DECEMBER, [illegible] No. 12

Journal

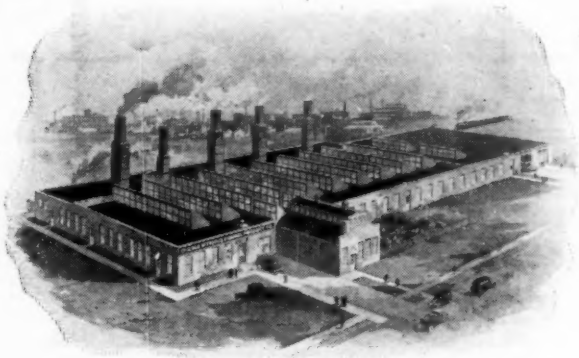
[illegible] Ceramic Society

[illegible]ects and The Bulletin

[illegible] devoted to the arts and sciences of the Ceramic Industries

CONTENTS

	Page
[illegible] Glass Composition—Noll	837
[illegible] of Oxidizing to Opacity in White Enamels—	855
[illegible] Coal Gas Producer Plant—Arnold	858
[illegible] Refractory [illegible]—Powell and Robertson	865
[illegible] Method of Procedure for Silica Brick—	889
[illegible] and Domestic Sewerage—Williams and	901
[illegible] of Clay [illegible]—Wilson and Hall	916
[illegible] Certain Clays and Its	926
[illegible] Crawford [illegible]—Spurrier	937
	939
	299
	340
	337
[illegible] Concrete to be Used over Glass Tanks"	339
[illegible] Publishing Collected Value for Glass-	339
[illegible] Coal Pots Used in Europe and Not in the	340
[illegible]	343
[illegible] of Coarse Ground Materials for Checker Brick in	346
[illegible] of Data on the Microscopic Properties of	348
[illegible] of Cost Frequently Overlooked	350
[illegible] Brick	359
[illegible] Effect of Degrees of Fig Iron upon the Enameling	360
	366
	375



THE NEW
CHICAGO VITREOUS SPEED-FORK

(Patent Pending)

Saves thousands of dollars each year in giving almost continuous use of Enameling furnaces.

It is easy and positive in its operation and the labor and fuel savings are especially marked, as by the old method the men were idle while waiting for the load to burn and again the furnace was idle while the men unloaded and loaded the fork. With this new device the men are getting ready a load while another load is burning, thus the furnace is continuously in use except the time taken in pulling out a load and putting in another, being thirty seconds.

Full particulars cheerfully given.

We also handle the later improved furnaces installed together with full equipment for enameling plants.

CHICAGO VITREOUS ENAMEL PRODUCT CO.
1407-1447 So. 55th Court, Cicero, Ill.

LUSTERLITE ENAMELS
CHICAGO VITREOUS ENAMEL PRODUCT CO.

Manufacturers of Higher Grade Porcelain Enamels for the Enameling of Steel and Cast Iron (Wet Process)

H F & G

H F & G TIN OXIDE

THE HARSHAW FULLER AND GOODWIN CO.

Cleveland

Chicago New York Philadelphia

JOURNAL

OF THE

AMERICAN CERAMIC SOCIETY

A monthly Journal devoted to the arts and sciences related to the silicate industries.

Publication Office: 211 Church St., Easton, Pa.
Editorial Office: Lord Hall, O. S. U., Columbus, Ohio.
Advertising Manager: L. R. W. Allison, 170 Roseville Ave., Newark, N. J.
Committee on Publications: R. H. MINTON, Chairman; H. F. STALEY, CHESTER H. JONES, E. W. TILLOTSON, ROSS C. PURDY.
Editor: ROSS C. PURDY; **Assistant Editor:** EMILY C. VAN SCHOICK; **Associate Editors:** L. E. BARRINGER, E. W. TILLOTSON, ROY HORNING, R. R. DANIELSON, A. F. GREAVES-WALKER, F. H. RHEAD, H. RIES, R. L. CLARE.

Entered as second-class matter July 15, 1918, at the Post Office at Easton, Pa., under the Act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 16, 1918.

(Copyright 1922, American Ceramic Society)

Eight dollars a year Single numbers, 75 cents
(Foreign postage 36 cents additional)

Vol. 5 **December, 1922** **No. 12**

ORIGINAL PAPERS

THE WEATHERING OF GLASS CONTAINERS[1]

BY K. L. FORD

ABSTRACT

Stability in storage is a requisite of commercial glass. A white film or surface spotted with white patches is frequently observed on glass that has been in storage for some time. These weathering effects can be produced artificially by several methods which are given. Several factors, including humidity, have been found to influence the rate at which weathering takes place. Dipping in hydrochloric acid before packing retards weathering and paper properly used in packing is effective in decreasing the tendency to weather.

Three classes of weathering effects are given and illustrated with microphotographs. Experiments show that continued boiling removes the weathered surface.

The products of weathering consist of crystals of soluble salt or salts, principally sodium carbonate, and an insoluble film.

The lime, soda, and silica are found to have the same relative values in the weathered material as in the original glass, with the addition of certain amounts of carbonate, moisture, and dirt and organic material.

Weathering is largely dependent on solubility. Glass showing the greatest resistance to weathering proves equally resistant to action of water at temperatures and pressures above normal.

Condition of surface appears to influence the solubility. Alumina increases the resistance of glass to weathering. Sodium carbonate may exist in glass after manufacture and assist in weathering.

[1] Published by permission of the Director of the Bureau of Standards of the U. S. Department of Commerce.

Introduction

Stability of Glass in Storage.—One of the requisites of commercial glass is stability in storage. Frequently the manufacturer or the dealer will find glassware, which has been held in storage for some time, covered with a white film or spotted with white patches. Attempts to wash the ware prove futile and a special treatment is necessary. The inconvenience and loss to the manufacturer who is required at times to hold in storage large amounts of stock reaches such proportion that weathering becomes an important problem. The Glass Container Association in coöperation with the Bureau of Standards is carrying out a study of this question tending toward the proper methods of handling the present type of commercial glass. The work has been confined principally to the composition of the film produced by weathering and a microscopic study of the resulting changes in the surface of the glass.

The occurrence of this breaking down of the glass surface is not limited to any special condition of storage, but appears to be very prevalent. In order to illustrate the extent of weathering, a few examples will be presented. Two cases representing the greatest difference in storage conditions are: (1) a beverage bottle stored in an open shed protected from the rain but subject to all atmospheric changes and (2) a druggist's bottle closed at the leer with a cork stopper, packed in a heavy pasteboard box, and stored in a modern well-ventilated warehouse. The period of storage was approximately the same. Both bottles showed on the inside a well-developed deposit which could not be removed by washing. Another sample of special interest is that of beverage bottles manufactured and stored in South America. These bottles were stocked in open bins subject to the action of the sun and rain. The composition of the glass was similar to that of the average American-made bottle. Weathering had developed to such an extent that large cracks were visible and several of the bottles burst when filled under pressure. Occasionally a druggist receiving perfectly clean ware from the manufacturer, which he places in a damp basement for storage, finds, when he opens the crates, severely weathered surfaces.

Water as Agent Producing Weathering.—Water is generally assumed to be the principal agent in producing weathering. This may exist as moisture deposited on the surface from the atmosphere or drops of water remaining on the surface after washing. Successive cycles of condensation by the heat of the sun or other methods of rapid drying appear to be quite effective in producing weathering. Such a condition is realized when ware, which has been washed to remove the products of grinding, is dried in a steam-heated room. In fact this drying process has been discarded by many manufacturers because of the frequent occurrence of white deposits

and iridescent areas on the inner surface of the ware similar to the effect produced by weathering. Ware dried slowly is generally free from such trouble.

Several attempts have been made to produce weathering artificially. A simple but effective method is to place a few drops of water in the bottle, tightly close the bottle and allow it to stand for several days. Then by repeating the procedure a sufficient number of times a film of considerable thickness can be obtained. Similar results are obtained by breathing into the bottle and closing tightly. Treatment at about 60°C, in an apparatus with thermostatic control and with an arrangement for blowing steam against the surface of the glass each day until a condensation was produced, and then allowing the surface to dry out, developed a distinct film within three weeks. Glassware stored in a special room where the humidity was very high and the temperature constant has exhibited deposits within a month, while the same ware stored in a dry room has shown no evidence of weathering even after a period of five months.

The manufacturer has found by experience that certain factors within his control appear to influence weathering. It has been observed that empty wooden boxes, stored in the open, when they become saturated with moisture during rainy periods, and then filled with ware and placed in dry storage, bring about weathering sooner than dry material.

Hydrochloric Acid Dip Retards Weathering.—Certain commercial glass products are dipped in hydrochloric acid before packing, to retard staining or weathering. Tests carried out at the Bureau and the experience of several manufacturers prove that this treatment decreases the tendency to weather. This is not, however, an absolute preventative, for tests have shown that after a sufficient period of exposure weathering does occur.

Paper Retards Weathering.—The packing of glass was considered a possible factor in weathering. The materials used in the construction of the pasteboard box were held directly responsible. Investigation of composition indicates that no injurious effect could be produced by any of the materials of the pasteboard box or of the paper in which the ware is wrapped. On the contrary, paper properly used has proved a distinct advantage in preventing weathering. Window glass is always packed with paper between the glass. While the principal reason may have been to prevent scratching of the surface, yet it has been observed that wherever the paper fails to cover the glass, weathering will take place in course of time.

Types of Weathered Glass

Weathered glassware differs considerably in appearance and seems to fall into three separate classes. This division is purely arbitrary. Class I (Fig. 1) is usually observed on ware stored in the open or for considerable

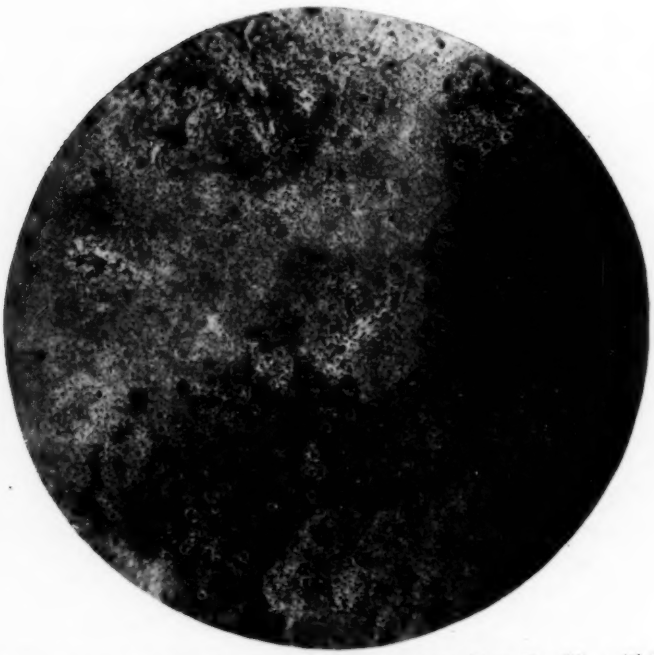


FIG. 1.—Weathered surface of green bottle glass, Class I. Mag. × 10.

FIG. 2.—Advanced stage of weathering, Class I. Mag. × 3.

FIG. 3.—Weathered glass, Class II (photographed with reflected light). Mag. × 3.

FIG. 4.—Weathered glass, Class II (photographed with transmitted light). Mag. × 10.

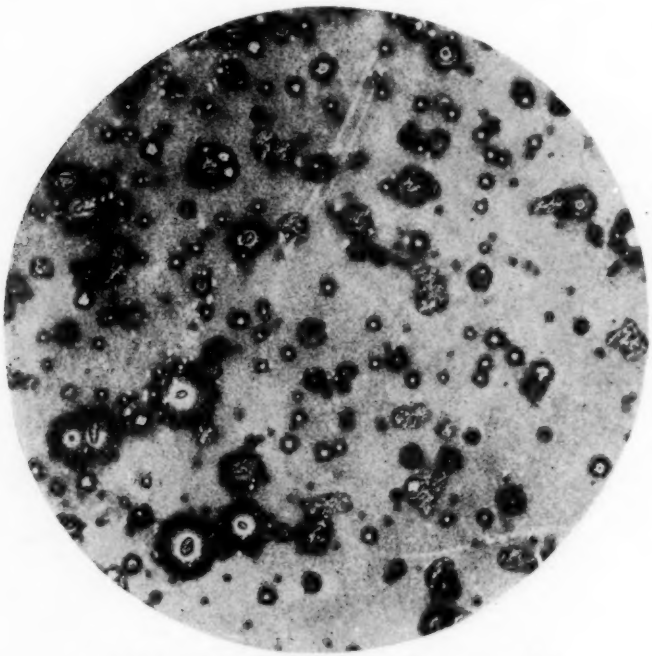


FIG. 5.—Weathered glass, Class III. Mag. × 3.

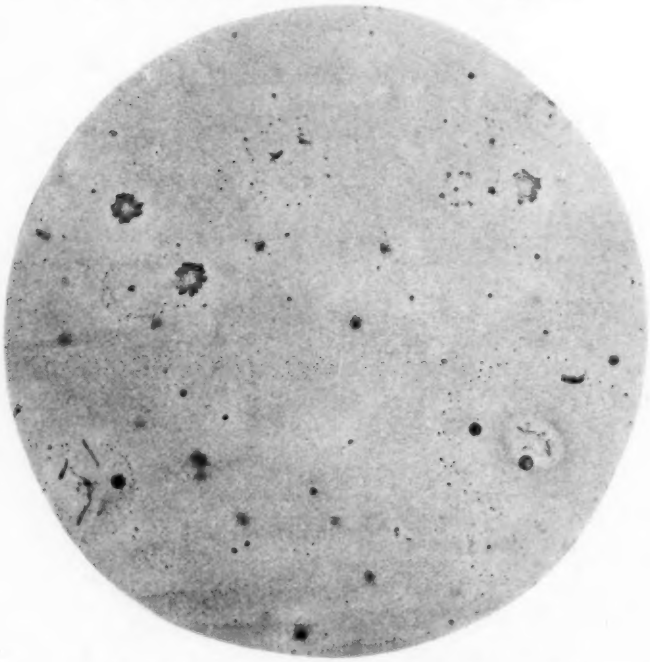


FIG. 6.—Weathered glass, Class III. Mag. × 10.

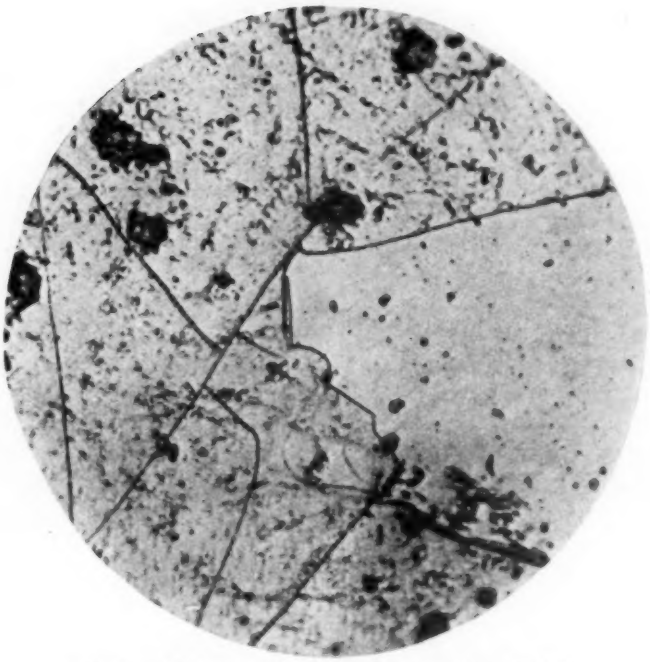


FIG. 7*a*.—Original weathered surface. Mag. × 250.

FIG. 7*b*.—Weathered surface treated with HF. Mag. × 250.

FIG. 7*c*.—Weathered surface after treatment with HCl. Mag. × 250.

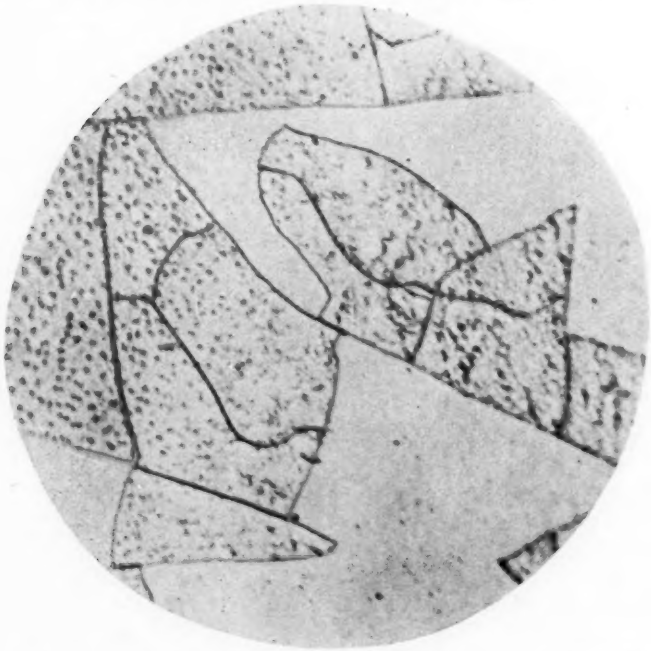


FIG. 7*d*.—Weathered surface after dipping in boiling water. Mag. × 250.

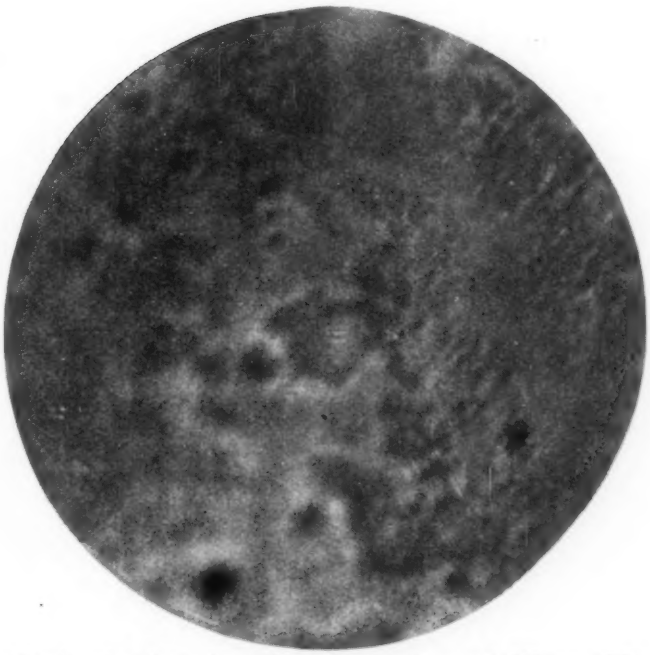


FIG. 7*e*.—Weathered surface after boiling in water for one-half hour. Mag. × 250.

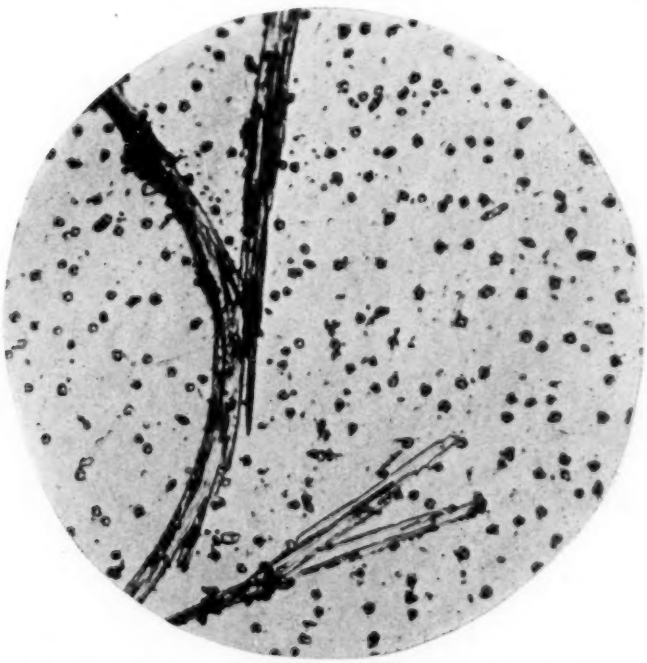


FIG. 8*a*.—Original weathered surface, Class II. Mag. × 250.

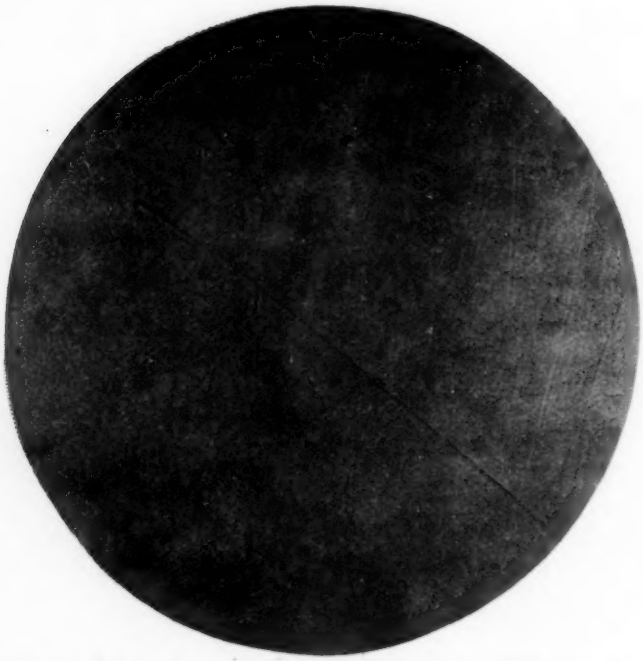


FIG. 8*b*.—Weathered surface after boiling in water for five minutes.

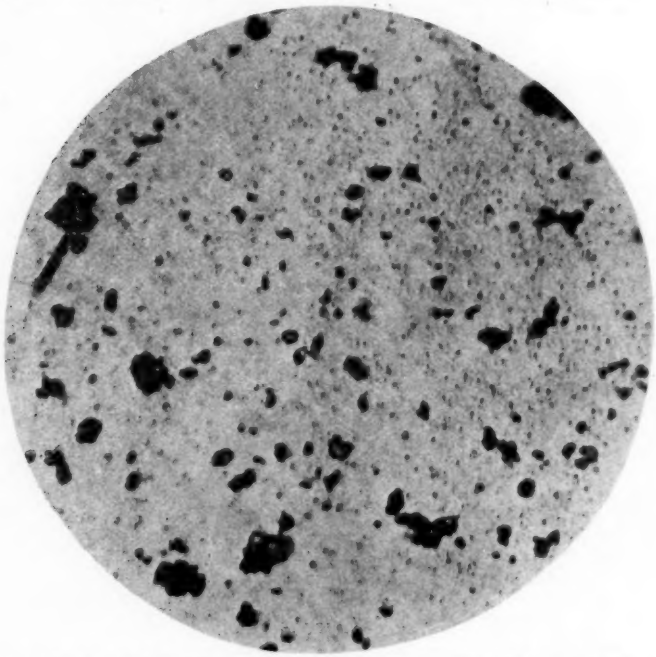


FIG. 9*a*.—Original weathered surface, Class III. Mag. × 250.

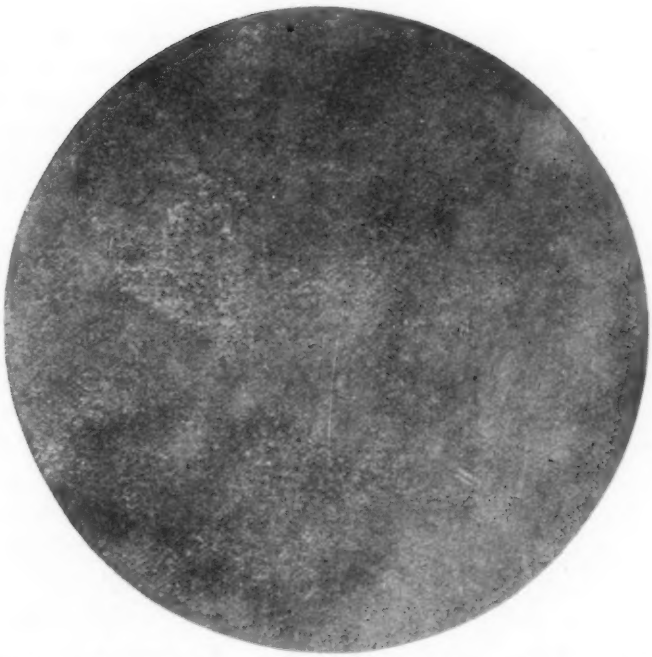


FIG. 9*b*.—Weathered surface after treatment in boiling water for 1 hour. Mag. × 250.

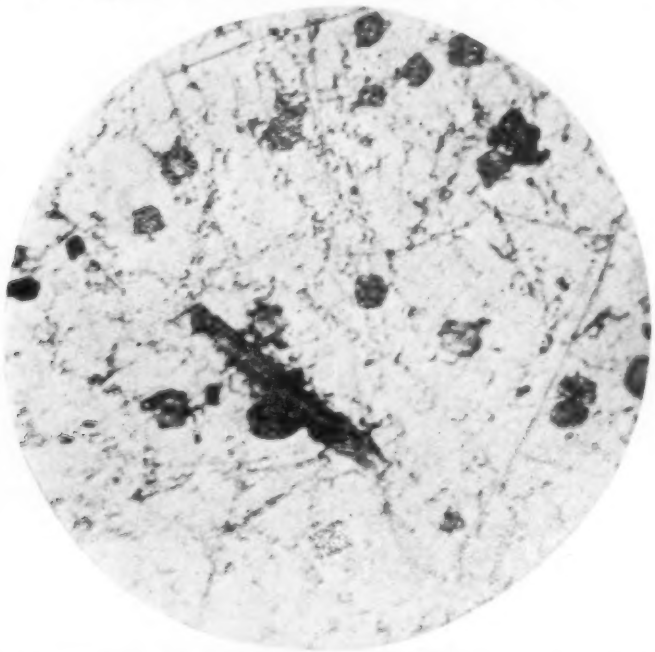


FIG. 10*a*.—Original weathered surface (parallel Nicols). Mag. × 250.

FIG. 10*b*.—Original weathered surface (crossed Nicols). Mag. × 250.

FIG. 11*a*.—Glass containing moisture heated to 350°C. Mag. × 250.

periods in warehouses subject to very wide and frequent changes in atmospheric conditions. The characteristic feature is the heavy white deposit which resembles the deposit obtained by the evaporation of a salt solution. Coal dust, dirt, and other foreign matter are included with the deposit. Fig. 2 shows a very advanced stage of this class of weathering. The film has broken up into small flakes, portions of which have separated from the glass. Crystals deposited by the evaporation of the alkali solution of the glass are evident above the film. Class II (Figs. 3 and 4) consists of needle-like crystals of alkali salts which resemble a web in their formation. No opaque film occurs in this case. Class III (Figs. 5 and 6)

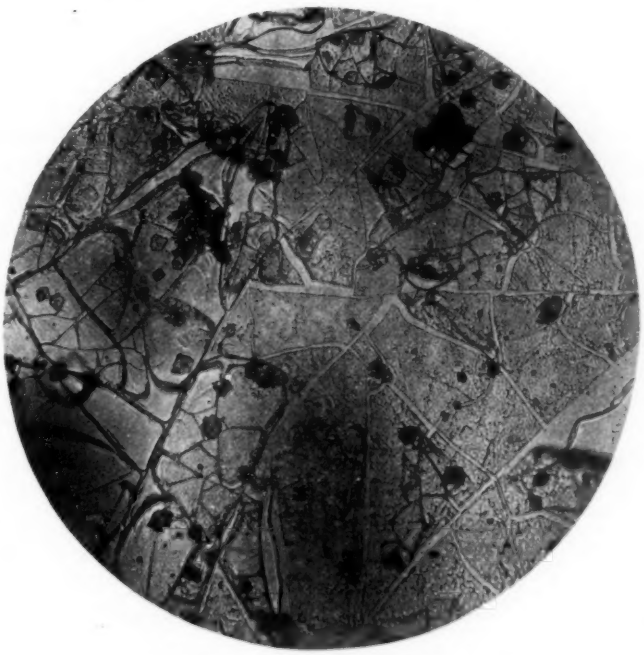


FIG. 11*b*.—Weathered glass heated to 350°C. Mag. × 250.

is, without doubt, the earlier stage of Class I and is the most common form of weathering found on commercial glassware. Small circular deposits surrounding crystals or dirt particles enable this type to be easily recognized. There is no continuous film on the surface and the weathering appears to be confined to certain areas.

Effect of Chemicals

A microscopic examination of the effect of a few simple reagents such as might be employed commercially for treating weathered glassware has been carried out and the photomicrographs taken at 250 diameters are

presented to illustrate the effects of the different reagents. Fig. 7*a* shows the original weathered surface of a light green beverage bottle, a typical Class I deposit. The bottle was stored in the open but protected from the rain. The outer skin is broken up into segments one of which has separated. Fig. 7*b* illustrates the solvent action of hydrofluoric acid which has attacked the entire film. Hydrochloric acid dissolves the crystals, but does not affect the film, as is shown in Fig. 7*c*. When the glass is dipped in boiling water several times a similar result is obtained. Fig. 7*d* is similar to Fig. 7*c* except that the boiling water has removed several portions of the film. Continued boiling removes the entire deposit giving the clean surface of Fig. 7*e*. The web-like deposit of Class II is easily removed by a few minutes treatment with boiling water. Fig. 8*a* affords a more detailed view of the crystalline formation of the deposit. Five minutes' boiling proved amply sufficient to remove all evidence of the deposit (Fig. 8*b*). A druggist's bottle which had the characteristic weathering of Class III was selected as a third sample. The deposit developed during a few months storage in a well-ventilated modern warehouse. In this case is was necessary to extend the boiling for almost an hour before the surface became entirely clear. Figs. 9*a* and 9*b* show the surface before and after treatment with boiling water.

Products of Weathering

The products of weathering are crystals of a soluble salt and a film of opaque material on the surface of the glass. The crystals exist in different forms and frequently occur when no film or formation of any other material is evident as in Class II. Photomicrographs, Figs. 10*a* and 10*b*, were made with the purpose of showing the crystal formation. This photomicrograph is the same as Fig. 7 except that polarized light was used. The first photograph was made with the Nicol prisms parallel and the result is similar to Fig. 7*a*. When the Nicol prisms were crossed the crystals alone are visible as white areas in the photomicrograph. Chemical analysis has proved these crystals to be principally sodium carbonate. The insoluble film shown in Fig. 2 was removed by brushing and its composition determined by chemical analysis. Different analyses did not check exactly owing to the impossibility of separating the film from all the small particles of glass. The following average of several determinations will give an idea of the composition of this material. The lime, soda, and silica are present in approximately the same proportions as in the glass.

SiO_2	CaO	Na_2O	CO_2	Moisture, organic matter and dirt
66%	7.5%	14%	7.5%	4.0%

Technical literature contains the results of numerous studies of the solubility of glass and its resistance to weathering which are not referred to,

the purpose of this paper being to present the information relating to glass containers in such a manner that the apparent causes of weathering will become clear to those interested in commercial glass. Some of the earlier methods used in obtaining results of solubility have been adapted to bottles and similar glass containers to illustrate the mechanism of weathering. The application of many of the results found and theories formulated have so far not been applied to glass containers. The glass manufacturer is interested in the action of atmospheric agents on the original surface of that type of glass common to American practice. The significant feature of this consideration of the problem is that the original surface is retained and any permanent change produced in the outer layer of the glass by the chilling effect of the mold or by the moisture content of the air employed in blowing exerts an influence on the final results obtained.

The generally accepted theory for the weathering of glass assumes that moisture condensing on the surface of the glass dissolves any soluble material. Such material is considered to be principally free alkali. The carbonic acid of the atmosphere reacting with the alkali in solution forms carbonates which crystallize out on evaporation. The action extends beyond this when moisture is absorbed by the glass and some soluble material below the surface is dissolved. When the glass dries this material in solution is deposited on the surface leaving the outer skin porous and marked with solution pits. Whether the moisture dissolves sodium silicate which is similarly affected by the carbonic acid is not certain. The appearance of certain deposits suggests that sodium silicate has been broken up into sodium carbonates and free silica. Boiling experiments carried out at the Bureau in which tumblers were used prove that glass dissolves to give a solution containing silica, lime and soda, although the soda is in considerable excess. At the same time particles of insoluble material resembling silica and insoluble silicates collect in the bottom of the containing vessel.

Solubility and Resistance to Weathering

The term "solubility" is used to express the relative rates at which glass is decomposed by water at definite temperatures and pressures to correspond with the present system of comparing glasses. Glass has no definite solubility in a strict chemical sense. The various reactions with water have a time limit and saturation with *glass* is never attained.

Weathering is largely dependent on the solubility of the glass. The most pronouncedly weathered glass examined has the highest solubility and shows more effect from treatment in the autoclave at 25-pound pressure for six hours.[1] Likewise the glass which was most resistant to weathering

[1] Williams, *Jour. Amer. Ceram. Soc.*, **5**, 508 (1922).

proved to be very resistant to the action of water at pressures and temperatures above normal. The effect of atmospheric conditions on these two glasses differs considerably. An analysis of these gives the following composition:

	SiO_2	R_2O_3	CaO	MgO	Na_2O	MnO
Glass A (the resistant)	76.2	(Al_2O_3–1.12) (Fe_2O_3 .005)	5.27	3.15	13.4	0.82
Glass B (green glass) (the badly weathered sample)	67.4	.80	8.47	.33	22.0	

Another glass of the following composition is typical of American practice. This glass gave a fairly pronounced deposit after several months' storage.

SiO_2	R_2O_3	CaO	MgO	Na_2O
72.15	0.52	7.57	1.01	18.75

The solubility of this glass is much less than that of Glass B and the durability under autoclave treatment is only slightly less than that of Glass A. Yet it has a greater tendency to weather than the first glass. It is evident that the weathering properties are partly dependent on the composition.

If glass, which has been boiled or subjected to water at high pressures and temperatures for a period sufficient to force water into the glass, is then heated fairly rapidly to about 350°C the surface will undergo a breaking up action giving the glass a "fuzzy" appearance. Fig. 11*a* shows the appearance of the surface after the above treatment. This action is accompanied by a loss in weight equal to .02–.05% of the weight of the glass. This appears to be the result of a rapid driving out of the moisture absorbed in the surface of the glass. If a sample of naturally weathered glass is heated in the furnace to 350°C in a similar manner the result shown in Fig. 11*b* is obtained. The two are practically identical in appearance. The surface change produced by heating proves that weathered glass absorbs moisture similar to glass which is subjected to water at high pressures and temperatures.

Chemical Composition of Glasses and Resistance to Weathering

A series of glasses which have been studied in this investigation was arranged in order of their lime to soda molecular ratios. The least ratio was 1 to 1.26. The glass giving this ratio had a silica content nearly equal to the silica content of several other glasses. The solubility, resistance to solvent action of water at temperatures and pressures above normal and

the general appearance were slightly superior to those of all other samples. The solubility and tendency to weather increased directly as the lime to soda ratio. The silica content differed slightly, but marked divergence in the two properties mentioned appears to be the result of the increase in soda. A very significant fact was the apparent effect of alumina. Glass with high lime to soda ratio and one per cent of alumina had properties consistent with a much lower lime to soda ratio. An increase in the amount of alumina exerts an influence on certain properties of the glass similar to an increase in lime, but for equal amounts alumina appears to be the more effective. There exists no well-founded theory for the action of alumina as both the acidic and basic properties are considered in the discussion. Frink[1] mentions the tendency of alumina to segregate in the outer skin of the glass. He claims this accumulation of alumina near the surface produces a skin effect which enables the glass to be more easily worked and also increases the resistance to solvent action and weathering. This particular phase will receive further investigation.

Effect of Condition of Surface

Another factor[2] which has considerable bearing on the question of solubility is the condition of the surface. Weathering generally appears on the inner surface, while spalling and chipping produced by treatment in the autoclave is confined to the outer surface. By roughening the inner surface with emery it is possible to obtain spalling on the inside of blown ware. By heating glassware to the plastic point it is possible to prevent spalling on the outer surface. These changes in surface condition resulting in changes in solubility indicate that surface conditions play a part that may be of some consequence. The almost universal occurrence of weathering on the inside suggests the possibility of factors introduced at the time of manufacture or conditions produced by the air used in blowing, which assist the reactions of weathering. This may be simply a surface effect.

The possibility of sodium carbonate existing in the glass after manufacture and thereby increasing the tendency to weather has occasionally been suggested. Determinations made by Masao Ikawa[3] give the amount of sodium carbonate as .021 to .055% but it seems probable that the presence of this salt may have been due to the action of the atmosphere on the ground sample. However, if sodium carbonate could be definitely shown to exist in the glass, near the surface, it would furnish an explanation of the tendency to weather, in short periods, in storage.

[1] *Trans. Amer. Ceram. Soc.*, **15**, 692 (1913).

[2] Williams, *loc. cit.*

[3] *U. Chem. Soc.* (Japan), **42**, 763–85 (1921).

proved to be very resistant to the action of water at pressures and temperatures above normal. The effect of atmospheric conditions on these two glasses differs considerably. An analysis of these gives the following composition:

	SiO_2	R_2O_3	CaO	MgO	Na_2O	MnO
Glass A (the resistant)	76.2	(Al_2O_3–1.12) (Fe_2O_3 .005)	5.27	3.15	13.4	0.82
Glass B (green glass) (the badly weathered sample)	67.4	.80	8.47	.33	22.0	

Another glass of the following composition is typical of American practice. This glass gave a fairly pronounced deposit after several months' storage.

SiO_2	R_2O_3	CaO	MgO	Na_2O
72.15	0.52	7.57	1.01	18.75

The solubility of this glass is much less than that of Glass B and the durability under autoclave treatment is only slightly less than that of Glass A. Yet it has a greater tendency to weather than the first glass. It is evident that the weathering properties are partly dependent on the composition.

If glass, which has been boiled or subjected to water at high pressures and temperatures for a period sufficient to force water into the glass, is then heated fairly rapidly to about 350°C the surface will undergo a breaking up action giving the glass a "fuzzy" appearance. Fig. 11*a* shows the appearance of the surface after the above treatment. This action is accompanied by a loss in weight equal to .02–.05% of the weight of the glass. This appears to be the result of a rapid driving out of the moisture absorbed in the surface of the glass. If a sample of naturally weathered glass is heated in the furnace to 350°C in a similar manner the result shown in Fig. 11*b* is obtained. The two are practically identical in appearance. The surface change produced by heating proves that weathered glass absorbs moisture similar to glass which is subjected to water at high pressures and temperatures.

Chemical Composition of Glasses and Resistance to Weathering

A series of glasses which have been studied in this investigation was arranged in order of their lime to soda molecular ratios. The least ratio was 1 to 1.26. The glass giving this ratio had a silica content nearly equal to the silica content of several other glasses. The solubility, resistance to solvent action of water at temperatures and pressures above normal and

the general appearance were slightly superior to those of all other samples. The solubility and tendency to weather increased directly as the lime to soda ratio. The silica content differed slightly, but marked divergence in the two properties mentioned appears to be the result of the increase in soda. A very significant fact was the apparent effect of alumina. Glass with high lime to soda ratio and one per cent of alumina had properties consistent with a much lower lime to soda ratio. An increase in the amount of alumina exerts an influence on certain properties of the glass similar to an increase in lime, but for equal amounts alumina appears to be the more effective. There exists no well-founded theory for the action of alumina as both the acidic and basic properties are considered in the discussion. Frink[1] mentions the tendency of alumina to segregate in the outer skin of the glass. He claims this accumulation of alumina near the surface produces a skin effect which enables the glass to be more easily worked and also increases the resistance to solvent action and weathering. This particular phase will receive further investigation.

Effect of Condition of Surface

Another factor[2] which has considerable bearing on the question of solubility is the condition of the surface. Weathering generally appears on the inner surface, while spalling and chipping produced by treatment in the autoclave is confined to the outer surface. By roughening the inner surface with emery it is possible to obtain spalling on the inside of blown ware. By heating glassware to the plastic point it is possible to prevent spalling on the outer surface. These changes in surface condition resulting in changes in solubility indicate that surface conditions play a part that may be of some consequence. The almost universal occurrence of weathering on the inside suggests the possibility of factors introduced at the time of manufacture or conditions produced by the air used in blowing, which assist the reactions of weathering. This may be simply a surface effect.

The possibility of sodium carbonate existing in the glass after manufacture and thereby increasing the tendency to weather has occasionally been suggested. Determinations made by Masao Ikawa[3] give the amount of sodium carbonate as .021 to .055% but it seems probable that the presence of this salt may have been due to the action of the atmosphere on the ground sample. However, if sodium carbonate could be definitely shown to exist in the glass, near the surface, it would furnish an explanation of the tendency to weather, in short periods, in storage.

[1] *Trans. Amer. Ceram. Soc.*, **15**, 692 (1913).

[2] Williams, *loc. cit.*

[3] *U. Chem. Soc.* (Japan), **42**, 763–85 (1921).

Conclusion

The investigation was confined entirely to soda-lime glassware of American manufacture. The attitude has been analytical. A few conclusions have been drawn regarding the occurrence of weathering on glass of different composition. The general conception is that under the proper conditions any type of commercial glass will weather in storage to a certain extent.

The author wishes to express his gratitude to Mr. A. E. Williams of this Bureau for his many helpful suggestions, and to thank Mr. R. A. Lofton of the Paper Section of the Bureau for his generous assistance in connection with the photomicrographs.

Research Fellow of the Glass Container Association
Bureau of Standards
Washington, D. C.

THE RELATION OF FINENESS OF GRINDING TO OPACITY IN WHITE ENAMELS

By B. T. Sweely and E. S. Prince

ABSTRACT

The problem of securing a uniform opacity by making observations of smelting, testing of raw materials, etc., led to the conclusion that the most important process was the mill treatment given the mixture. A table showing screen analyses of white enamels is given.

The question of opacity is always of interest to manufacturers of white enameled wares, inasmuch as the cost of the enamel is usually dependent upon the opacity of the enamel used. It is almost an axiom that there is no such thing as a cheap white enamel, since the materials which lend opacity, *i. e.*, tin oxide, kryolith, etc., are usually the more costly of the raw materials used, and a given opacity can be secured only by the use of sufficient of these opacifiers to bring about the desired result.

The writers were led to investigate the relation of fineness to opacity, by the difficulty encountered in trying to control the opacity of two-coat ware, that is, ware having a single coat of white enamel applied over a ground. Our problem here was to secure a uniform opacity from piece to piece and from day to day, it being not unusual to experience variations in such ware that would render 40 or 50% of a day's run too dark to be salable, and necessitate redipping, burning, etc. After careful observations of smelting, testing of raw materials and so forth we were forced to the conclusion that the solution of our trouble lay in the mill treatment accorded the mixture used, and we therefore proceeded to make a systematic study of our milling conditions.

The conditions in our factory do not lend themselves readily to the storing or "aging" of the finished enamel. It is, I believe, the practice in some factories to age the enamel for some little time after milling before it is placed in the dipping tubs, thus allowing any excess water that may be present to "settle off." Lack of space at our shop does not permit this, and we are forced to use our enamel either right from the mills, or within twelve to twenty-four hours. Under these conditions it was important that we keep our water content at a minimum in order to secure the proper dipping consistency and therein lay our trouble.

We found in our study that a variation of one-half a cubic foot of water added at the mill in a glass charge of one thousand pounds made a decided difference in the fineness of the finished enamel when milled for a given time. Such a variation in water content was not at all unusual due to the varying lengths of time the glass used had stood or "drained" after smelting. The result was a variation in fineness and consequent opacity when the enamel was applied to the ware.

The reason for such variation is rather obvious. Opacity is essentially

a refraction phenomena and if the maximum effect from any opacifier used as a mill addition is to be attained, it is necessary that the opacifier be finely divided and evenly disseminated throughout the coat of enamel in which it is used.

Since the glass itself as used for steel ware is not usually opaque enough to produce a suitable enamel without the use of an opacifier in the mill, it follows that any particle of glass that has as great a diameter as the thickness of the coat applied will have only the opacity of the glass itself, since in this case no refraction of light by the particles of tin or other opacifier can take place. The result will be a grey or spotted coat of enamel.

Obviously, if the above is true on rather coarse particles of glass, the same will be true at any degree of fineness since the more perfectly the particles of glass are separated and surrounded with the opacifying particles, the more perfect will be the refraction of the light falling upon the finished ware and the greater the opacity. For this reason we decided the solution of our problem lay in controlling the fineness of the milled enamel and consequently proceeded to run a number of screen analyses of the enamel as it came from the mills. Below are given data on a number of screen analyses run on the glass during these tests:

TABLE I

SCREEN ANALYSES OF WHITE ENAMELS

No.	60	80	100	120	150	200	H_2O%	Sp. gr.	Mill time
0	0	3.47	5.57	22.35	29.12	50.87	26.5	1.867	20 hrs
1	0	0	.64	12.48	19.12	42.22	28.6	1.827	20 hrs.
2	0	1.18	2.02	16.15	23.21	45.76	28.1	1.833	21 hrs.
3	0	0	0	8.2	14.10	38.50	28.01	1.842	23 hrs.
4	0	0	0	3.81	9.35	31.9	29.2	1.816	22 hrs.
5	0	.34	.65	9.35	15.81	39.91	28.29	1.830	22 hrs.
6	0	0	0	7.94	10.51	32.92	29.70	1.808	21 hrs.
7	0	0	0	6.00	11.27	33.77	29.4	1.815	22 hrs.

The data given is the per cent of glass retained on the respective screens. The water content is expressed in terms of the wet weight of the slip. These tests were all made on samples taken from different runs on the same mill under factory conditions before any attempt was made to standardize the milling beyond weighing the glass and measuring the water.

Of these enamels Nos. 0, 1 and 2 were too coarse to give good opacity on two-coat ware. Nos. 3, 5, 6 and 7 all produced enamels of good opacity, and dipping properties, while No. 4 was very opaque but difficult to dip uniformly. The conclusion drawn from these data was that for this type of ware and under our factory conditions, the best results were to be expected when the glass was milled to a fineness such that all would pass 100-mesh and from 5 to 10% be retained on 120-mesh.

The results of this study we at once put into practice with very good

results. We succeeded in eliminating much of the variation in opacity noted above, and have secured more consistent results on all our ware by following the practice of testing for fineness before putting the enamel into use.

It is our opinion that control of the grinding operation on this basis, will largely eliminate the necessity for aging the enamel when it comes from the mill. We have made a number of comparative tests with aged and freshly-milled enamels and have never found any difference in the opacity of the ware, where fineness, specific gravity and water content were the same at the dipping tub. While this may be due in part to the clay used, as compared with that used by others where aging is thought to be beneficial, still it is hard to understand how the opacity of an enamel can be improved by aging in water a number of insoluble ingredients.

In general, it might be said that proper milling is equal in importance to any phase of the enameling process and closer control at this stage of the preparation of the enamel will go far toward the elimination of many of the defects that occur during the application of the enamel to the ware.

CERAMIC LABORATORIES
COONLEY MANUFACTURING COMPANY
CICERO, ILLINOIS

Discussion

Mr. WELLS:—I take it that the finer the enamel the more opacity you get. I would like to ask Mr. Prince if there is any limit to the fineness.

Mr. PRINCE:—We have not gotten to the place we should to determine that point, but we make our determinations on the ground enamel passing a given mesh. We like to get it passing 120-mesh.

Mr. POSTE:—Is that sprayed or dipped?

Mr. PRINCE:—It is dipped. This all applies to dipping. I have not had any experience in other lines, and all I said applied to dipping. The fineness of the enamel always has a great deal to do with its dipping properties. Those of you who have dipped enamel know that if it is coarse you can handle it more easily than you can the finely ground, so the difficulties you run into when it is finely ground will be appreciated by some of you. That is, when you take it directly from the mill and dip it.

Mr. MANSON:—I would like to ask if, with the actual weight of dried enamel, from a piece in each case, it would not be possible that you really get more enamel on the piece when it is coarse.

Mr. PRINCE:—I would say these tests are not laboratory tests. We would run one hundred samples set up in the same consistency by the same individual. The results were conclusive to us.

MANUFACTURE OF SINGLE COAT GRAY ENAMELED WARE[1]

By Howard C. Arnold

ABSTRACT

The manufacture of single coat, mottled gray enameled ware presents a diversity of problems as will be evident from a casual consideration of the following specifications.

1.—The black shape has to be completely covered in one coat as the lack of a second, or cover coat makes it impossible to hide a blemish, scratch or mark.

2.—This coat must have all the gloss, luster and appearance of a finish coat.

3.—It must show two colors, and these colors must be produced from the same enamel and in a single dipping.

4.—The two colors must be present in correct amounts and, at the same time, must be distributed in such a way as to give a pleasing effect.

Preparation of Black Shape

In general, the black shape is prepared in the same way as in the multi-coat process. There appears considerable difference of opinion (and this is shown in varying practice) in the relative value of caustic cleaning and annealing, or scaling. Most of the larger plants making both single and multi-coat ware anneal their black shapes. However, in some of the single coat plants, caustic cleaning is being used entirely.

Sulphur annealing has been used in the past in preparing shapes, according to which the shapes were packed in metal containers, sprinkled with sulphur, sealed and then annealed for 6 or 8 hours at 1000° to 1200°F. Just what this accomplished is hard to say. No doubt the sulphur served to deoxidize the atmosphere and prevent the formation of scale, and the annealing may have assisted in the mottling by removing all strains in the steel, thereby making it more uniformly susceptible to the attack of the mottling reagents. This process, the writer believes, is still in operation in some plants, but in most places has been abandoned. It will, therefore, not be considered further.

The writer's experience with annealing and caustic cleaning has been sufficient for him to make a definite decision between the two. It has led him to the conclusion that when caustic is used, it is not always possible to get every article properly cleaned. Pieces made from rusted steel, or which have been subjected to severe spinning or drawing action, usually give trouble, while fabricated shapes, and shapes which have been subjected to only slight drawing, are cleaned quite successfully. In general, caustic cleaning is about 80% as reliable as acid dipping and scaling, (or annealing).

In cleaning we have used caustic soda, sodium carbonate, trisodium phosphate and silicate of soda mixed in various proportions. In all cases, an approximately 8% solution of these mixtures is used for the cleaning. The articles are boiled from two to three hours. They are tested for grease by the man in charge, who notes whether the film of water breaks as it runs

[1] Contribution from the Laboratory of Arthur D. Little, Inc., Cambridge, Mass.

off the piece. The shapes are then boiled a second time in water in order to remove all adhering caustic before they are placed in the pickling tanks.

Pickling practice in single coat gray is practically the same as in multi-coat ware. Four to eight per cent hot sulphuric, or cold hydrochloric, acid is used. In connection with hot sulphuric acid pickling, it is quite common to use a so-called inhibiter, the function of the inhibiter being primarily to minimize disagreeable fumes. The ware is pickled fifteen to forty-five minutes, it is then washed, and finally neutralized in a weak soda ash bath. From the neutralizing bath it goes to the dryers, with the exception of some plants practicing "wet-dipping" where it is retained moist as will be explained later.

Enamel Formulas and Preparation

Several volumes could be written on this topic alone. The pros and cons of the various ingredients which make the batch formula have furnished a topic of discussion for years past, and, as far as we can see today, will continue to do so for years to come. The difficulties involved in controlling all variables but one, in determining the effect of various ingredients on the finished article, are well nigh insurmountable. Of course, we can get directions, but to get quantitative measurements is practically impossible. It is beyond the scope of this paper to enter upon such a discussion; the commercially accepted formulas alone will be considered.

With one exception, the clay, the ingredients used in single coat gray ware are the same as those in multi-coat. As the clay functions as the opacifier, as well as the suspending medium, it has to have additional properties. In the writer's experience, the ordinary plastic ball clays, such as are used in multi-coat ware, when applied to single coat gray, do not give the proper finish. Either they burn too dark or produce a rough surface with no gloss. Usually the fat clay merely dissolves in the enamel frit, leaving the coating black. The clay must have the power of floating the enamel frit, or "set up," and, at the same time, it must resist the fluxing action of the glass during burning. What is required can best be described as a plastic kaolin, or china clay. Fortunately, the gray color makes it possible to use other than white burning clays; even those stained considerably with iron are satisfactory. To realize the best conditions, a blend of clays can be used such as a refractory plastic with a ball clay.

Another method for producing opacity is the use of an opacifier with a clay which will dissolve in the frit when the piece is burnt. Various substances have been tried, such as tin oxide, antimony oxide, magnesium spinel, aluminum hydroxide, titanium oxide, zirconium oxide, fine ground diaspore, etc. With these ingredients, however, we strike the following difficulty. Clay, when subjected to the action of mottling salts, is dissolved or fluxed in the area of the mottle and left unattacked outside. The opaci-

fiers mentioned above seem to resist the mottling salts, and, instead of getting the dark areas necessary to produce contrast in the light and dark of the enamel, we get only a faint darkening in the mottled areas, which at a distance gives the impression of a solid color. Besides the above objection, in the case of tin and antimony oxide, there is a further one, a reducing action of the sheet steel on the oxides to form the lower oxides with an accompanying discoloring and blistering. Zirconium oxide is not affected by the steel, and, in its basic silicate form, gives better results than any of the other compounds. The same bleaching effect on the mottle is produced from cryolite, or any combination of aluminum and fluorine in the frit, although not to the same extent as in the case of a solid opacifier.

Various single coat formulas have been published, and the writer ventures to say that, in the ratio of refractories to fluxes (this being the fundamental proportion which must be correct) 90% of the formulas in production today do not vary 15% from those published. Of course, there are a great many ways in which there can be a variation in adding the refractories and fluxes, but the fundamental condition is fulfilled. Danielson[1] has published formulas which may be taken as typical. Our best results have been obtained with a high feldspar, low quartz and fluorspar mixture. The refractories and fluxes are balanced accordingly.

Here again, the single coat enamel is subject to a great many troubles not found on multi-coat. For instance, we have a phenomenon called depressed mottling. That part of the surface where the mottling salts are concentrated will burn to a thinner coating than the other part, and, as a consequence, will form a depression on the surface. If we decrease the calcium oxide, we encounter this trouble. Cryolite, in small amounts, is beneficial in producing opacity, but, as explained above, its use is limited. Furthermore, opacity obtained with cryolite produces a less substantial, more soluble enamel than when it is produced with clay. We have obtained good results with the following formulas:

Feldspar	33.50	48.0	38.0
Sodium carbonate	12.50	3.0	4.5
Sodium nitrate	3.75	3.0	4.5
Borax	24.50	29.0	28.0
Fluorspar	6.75	4.0	5.0
Quartz	15.00	...	12.0
Oxide antimony	1.50	2.0	2.0
Cryolite	3.25	3.5	4.0
Bone ash	3.75	3.0	...

The influence of other factors in production is far greater than that of formulas, and, unless these other factors are properly balanced, the best formula ever written will not make good enamelware.

[1] R. R. Danielson, "A Classification of Enamels for Sheet Steel," *Jour. Amer. Ceram. Soc.*, **3**, 961 (1920).

Making the Batch

The raw batch is fritted in a rotary smelter which is fired with oil. Batches of 450 pounds are smelted at one time, taking from 1.5 to 2 hours per smelt. The frit is quenched in the usual way, then dried and stored.

The making of the enamel from the frit will depend upon the method of dipping. There are two methods in use:

1. Wet dipping method, in which the mottling agent (usually a weak solution of H_2SO_4) is on the black shape.

2. Dry dipping method in which the mottling solution is added in the enamel.

In the first method, the wet dipping, the black shapes are either brought directly from the pickling room without drying, in which case they still retain a small amount of acid from the pickling vats, or the pieces are dried in the pickling room in the usual way, and then immersed in a weak acid solution just before dipping.

In the second case, a mottling salt is added to the enamel, either on the mill, if the enamel is to be used immediately, or just before dipping. The effect of these salts is dissipated upon standing. Various salts can be used. Among those most common are cobalt sulphate, nickel sulphate, and ferrous sulphate.

The frit, with 5 to 7% clay and 50% water, is ground in a ball mill to pass 80-mesh screen. Fifteen minutes before a mill is finished, $^1/_2$% magnesium sulphate is added. The enamel is then ready to use. We let it age for three or four days, although the writer cannot say definitely that this aging has any beneficial effect.

Dipping

In the wet process, care must be taken that the water content does not become too high. As each piece dipped carries with it a certain amount of water, and leaves it in the dipping tub, it is necessary to add, from time to time, a certain amount of thick enamel. This may be done at the discretion of the dipper, or under the direction of the forelady.

In dry dipping, there is little variation from standard practice. The pieces are not shaken so hard as they are in ground coat; the layer of green enamel is much thicker. Just before dipping in the enamel from $^1/_2$ to $^3/_4$% of mottling salt in solution is added. Because of the thick coating desired, the resultant thickening of the enamel is not disadvantageous.

Mottling and Drying

The mottling or corroding reaction from a chemical point of view is very complicated. It is controlled by the following conditions:

1. The purity of the iron.

2. The distribution and size of particles of the impurities in the iron (structure).

3. The degree of alkalinity or hydroxyl-ion concentration of the enamel.

4. The degree of oxidation of the iron salts formed in the reaction.

The rusting is due to a difference in electric potential between electro positive and electro negative areas, on the surface of the iron. The electrically opposed areas are formed from the impurities in the iron, and they, as well as the potential difference between them, will vary with the kind of impurity and its distribution or grain size.

With a given steel surface, the extent of the running of the mottle, or the control of its character, is regulated by the alkalinity of the enamel and the extent of oxidation of the iron salts formed. The three mottling salts mentioned are all salts whose bases are insoluble. When they have been in contact with the alkaline sodium silicate or hydrate (which can be present in very small amounts only) the sodium ion will unite with the sulphate ion and the cobalt or nickel will be precipitated as the insoluble hydroxide.

It is the acid nature of these cobalt, nickel or iron salts which momentarily furnishes a negative ion that produces the mottling. If the salt has been standing in the enamel too long, or if the enamel has too high a hydroxyl concentration, the above reaction will have been completed and the salt will have lost its mottling effect. Then, in place of connected runny mottling, we will have a series of dark spots, each with a high concentration of ferrous salts. In fact, the concentration becomes so great at times that red oxide of iron is formed on burning and leaves red spots.

The condition of oxidation or reduction in the enamel, as has been stated above, is of effect in determining the character of the mottle. The reason for this is as follows: When the iron sulphate formed by the corrosive action of the enamel on the metal succumbs to the hydroxyl ion and is precipitated, it will precipitate as one of two compounds, ferrous hydroxide or ferric hydroxide. The ability of ferrous hydroxide to form colloidal suspensions, and thus to diffuse farther after its formation than the ferric hydroxide, makes it give better mottling effects. This can be easily shown by experimenting with a highly alkaline enamel, with and without a strongly reducing agent. The spots with red centers will develop immediately in the first experiment, while the dark mottled area will run in streaks all over the piece in the second. There is, of course, a limit in the selection of reducing agents. Organic reducing agents will blister and blow when the piece is burned. Sodium thiosulphate gives good results; cobalt and nickel salts also function as reducing agents.

In the wet dipping method the chemical control of the enamel is not necessary. The mottling agent (weak sulphuric acid) does not touch the enamel until the enamel is in contact with the steel. In this way it has the

maximum length of time to react before the ferrous sulphate is precipitated as hydroxide. Furthermore, there is no insoluble base to be precipitated. Even here, in the writer's opinion a small amount of reducing agent would be advantageous.

The wet process is very reliable, not so susceptible to external influences, and can be depended upon to run constantly. The dry dipping process must be controlled more carefully. As stated before, the alkalinity or hydroxyl-ion concentration is very important. This can be determined by titration of the water in the enamel, and corrected by addition of acid. However, it is much better to have the enamel at its correct alkalinity.

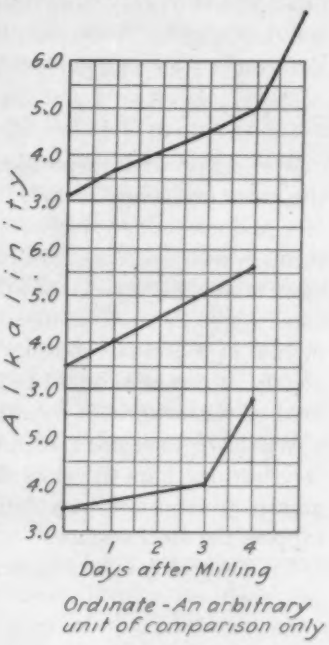


FIG. 1.

The alkalinity is dependent upon many conditions, the more important being (1) the ability of the frit to resist the action of water in the enamel, (2) the age of the enamel. It is, accordingly, best to use the enamel before the alkalinity has developed beyond the maximum point allowable as shown by experience. On the other hand, over-correction with acid, or an enamel with too low an alkalinity, gives no mottle at all. That is, a dark color will cover the whole piece and there will be no light areas to produce contrast. The color produced is not so dark as that produced with the proper alkalinity. Here the correction is made by blending in old enamel of high alkalinity. The curves in Fig. 1 show the increase in alkalinity of an enamel with increase in age. These were taken from actual enamel batches waiting to be used.

The time required for developing the mottle is from two to two and one-half hours. In order that the proper reaction be produced, the piece must be kept moist, just as it comes from the dipper, for this length of time. There are two methods of obtaining this result: (1) Regulate your temperature and humidity conditions so that the piece is almost dry when the mottling is completed and it is a matter of only a few minutes for it to become completely dry, or (2) keep the temperature of the mottling normal and pass the completely mottled piece through a rapid dryer, where it can be dried quickly. If the ware is dried too slowly, or remains in the moist condition too long after mottling is completed, we may get too high a concentration of iron salts, and then, on burning, these salts will not be taken up

by the frit, but will give off gases and produce small black spots or pinholes.

The process of drying, with the exception of the mottling phase, is the same as for multi-coat. The ware is placed on trucks from the dippers, left in the mottling room and either dried completely in the mottling room, or passed from there to a rapid dryer. In some plants, steam racks are used instead of kilns. The amount of steam and the temperature of the racks will be regulated according to external conditions; in hot weather it is not necessary to use any steam, while in cold weather, when the air has low evaporating power, steam is required.

Burning

Burning presents no problems not met with in multi-coat ware. We have the same problems of capacity and type of furnace, kind of fuel, style of fork and number of operators on a fork. We have used the fire-clay muffle furnace, coal fired, and the carborundum muffle, oil fired. The carborundum muffle is very elastic; it can be heated to full burning temperature, 1550–1600° in 4 to 6 hours. Temperature changes can be made rapidly; in case of a Sunday shutdown, or where the furnace has not cooled completely, it can be brought to heat in 3 hours. Electric furnaces and direct fired oil furnaces, both without muffles, are new developments in this field.

We have our share of trouble from overburning and underburning. Overburning kills the gloss and burns the edges dark. When the ware is greatly overburned, it volatilizes the enamel, turns the ware black, and exposes the steel surface.

Underburning leaves blisters and fine pinholes although the gloss is usually good.

Fishscale

No paper on enamelware would be complete without some mention of this problem. We have periodically a certain amount of fishscale. It would extend this paper to too great a length to present a discussion of its causes and control. In single coat gray ware, fishscale is encountered much more than in multi-coat ware. The mottling process, the variation in chemical nature between light and dark areas, and the strains that are thereby introduced, make this enamel more susceptible to fishscale than multi-coat. The necessity of burning one coat to a gloss is also a contributing factor. Fishscale, to a certain extent, is independent of the batch formula. No amount of variation in the formula is entirely sufficient in itself to eliminate scale.

In conclusion the writer wishes to acknowledge his indebtedness to Crunden Martin Manufacturing Company, St. Louis, Missouri, where his experience in this field has been acquired as a representative of Arthur D. Little, Inc., 30 Charles River Road, Cambridge, Massachusetts.

CHROME REFRACTORIES[1]

By J. Spotts McDowell and H. S. Robertson

ABSTRACT

A compilation from the available literature is presented, giving the more important data on chromite and chrome refractories. A bibliography is included.

Introduction

The high refractoriness and neutral chemical character of chrome give it an important rôle as a refractory in various types of metallurgical furnaces. However, comparatively little study has been given to its refractory qualities and the literature upon the subject is surprisingly scant. What little there is, is scattered throughout the technical press, and is not readily available. The authors have endeavored to bring this scattered information together, and to supplement it by certain additional data from the laboratory of the Harbison-Walker Refractories Co.

If the properties of chrome ore were thoroughly understood, its use as a refractory material would doubtless be greater. Producers, consumers and investigators should realize that the commercial term chrome ore embraces a group of materials of different chemical and physical properties. Realization of this fact may prevent misinterpretation of results, and make possible the more intelligent use of chrome refractories. The authors hope that the presentation of the data here compiled will lead to further research upon this valuable refractory material.

Historical Note

The first recorded experiments with chrome ore as a refractory were made in the open-hearth furnaces at Terre-Noire, France, in 1879.[2] It was used on a larger scale in the following year at the Alexandrowsky Steel Plant, St. Petersburg. The first recorded use of chrome brick was in England, in the year 1886.

At the Alexandrowsky plant, the hearths of the basic open-hearth furnaces were made of calcined dolomite and other parts of silica brick. A six-inch layer of crushed chrome ore mixed with tar separated the dolomite from the silica. The dolomite for the hearths was calcined in a shaft kiln lined with lumps of chrome ore. These lumps were bonded together with a mixture of two parts by volume of chrome ore fines and one part of lime. By 1886 chrome ore had been adopted at several European open-hearth plants as a lining material for the walls and hearths. These were constructed of blocks of ore laid in a mortar of chrome ore fines, to which lime

[1] Received October 20, 1922.

[2] Ferd. Gautier, "On a Neutral Lining for Metallurgical Furnaces," *Jour. Iron Steel Inst.*, **28**, 151 (1886); *Stahl u. Eisen*, **6**, 504 (1886).

[3] O. T. Tellander, "The Basic Open Hearth Process at the Alexandrowsky Plant, St. Petersburg," *Stahl u. Eisen*, **2**, 599 (1882); *Jour. Iron Steel Inst.*, **22**, 465 (1883).

had been added to cause setting. The hearths were 8 to 10 inches thick. A mixture of the ore and tar was used to fill the tapping holes.[1]

For several years prior to 1886 chrome ore had been used in the basic converters at Eston, England. The bottom walls were lined with dressed blocks of the ore, and dolomite was rammed around the blocks. These linings were said to have given good service.[2]

About 1886 Riley made chrome brick bonded with tar and a small amount of fluxing material. From his description it appears that the brick were not burned before use.[3]

In the late eighties chrome ore as a hearth material for open-hearth furnaces was supplanted by magnesite, which was found to be much more satisfactory. By 1890 chrome was no longer used for this purpose in Russia or Germany,[3] although it was used in France in minor degree as late as 1895.[4]

The use of chrome ore as a refractory in the United States began about 1896. It was employed in the brick form mainly as a neutral course between silica and magnesia brick, and in the ground condition for patching and daubing in open-hearth furnaces. Only a few companies in the United States have ever manufactured chrome brick.

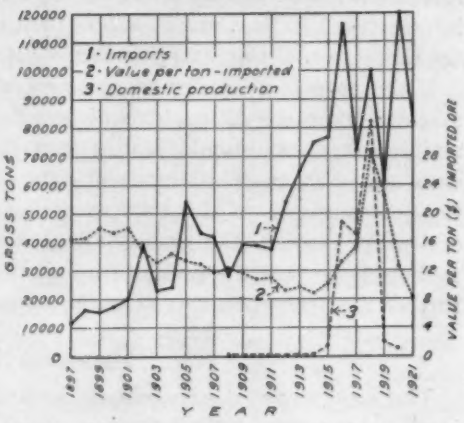


FIG. 1.—Annual consumption of chrome ore in United States.

For many years prior to the war, all but a very small portion of the chrome ore used in this country was imported, mainly from New Caledonia, Greece, Turkey and South Africa. From 1905 to 1914 the average consumption of chrome ore in the United States was about 45,000 tons for metallurgical, chemical and refractory purposes combined. About 35% was used for the manufacture of ferro-chrome, 35% for chemicals, chiefly bichromates, and 30% for refractories and other purposes.[5]

[1] "Chrome Ore as a Furnace Lining," *Stahl u. Eisen*, **7**, 27 (1887).

[2] Ferd. Gautier, *loc. cit.*

[3] "Chrome Iron Ore Linings in Open-hearth Furnaces," *Jour. Iron Steel Inst.*, **34**, 340 (1889); "Chrome Iron Ore Linings," *ibid.*, **36**, 217 (1890); Dr. Leo, "Chrome and Magnesite Brick," *Stahl u. Eisen*, **11**, 643 (1891); *Jour. Iron Steel Inst.*, **40**, 165 (1891).

[4] P. Speier, "Chrome Ore Furnace Lining," *Echo des Mines*, **21**, 584 (1895); *Jour. Iron Steel Inst.*, **48**, 506 (1895).

[5] J. S. Diller, "Chromite in 1918," *Mineral Resources of the U. S.*, **35** [1], 657 (1918).

During the war period there was an unprecedented demand for chrome ore, and prices became so high that California and Oregon ore could be shipped to the Eastern market at a profit, notwithstanding the expense of transportation. Imports reached a high figure. Nearly all of the ore, however, was needed in the metallurgical and chemical industries, and the manufacturers of refractories obtained only a limited amount. At the end of the war, prices again dropped, and little or no chrome ore is now being mined in this country.

TABLE I[1]

CRUDE CHROMITE IMPORTED TO THE UNITED STATES AND SHIPPED FROM MINES IN THE UNITED STATES[2]

Quantities in Long Tons

	1913	1914	1915	1916	1917	1918	1919	1920	1921
Australia	....	....	....	2986	....	15976	13161	2778	....
Brazil	....	....	....	....	....	17854	4800	3451	....
Brit. South Africa	....	....	22800	23000	4750	521	29	39400	23318
Canada	....	533	10087	12200	19012	20949	8941	8491	7554
Cuba	....	....	....	34	17	8821	14461	710	600
French Oceania	21850	30860	28031	30950	10300	25761	7125	56682	35108
Greece	4600	8155	4305	7900	....	....	....	5302	8104
Portuguese Africa	30001	23200	11230	38850	37800	8000	4000	11000	....
Asiatic Turkey	8650	11880	....	....	....	....	3500	12760	5822
All others	79	58	2	5	184	2260	4387	9701	1330
Total	65180	74686	76455	115925	72063	100142	60404	150275	81836
Domestic Sales	255	591	3281	47035	43725	82430	5079	2502	....
Apparent Consump.	65435	75277	79736	162960	115788	182572	65483	152777	....

Mineralogy

The most common mineral containing chromium, and the only one of economic importance, is the oxide, chromite ($FeO.Cr_2O_3$). Other not uncommon minerals containing chromium are picotite (chrome spinel), crocoisite (lead chromate), chrome diopside, chrome garnet and chrome mica.

Chromite is a member of the spinel group of minerals, which crystallize in the isometric system, and which have the general chemical formula $RO.R_2O_3$. Some of the members of this group are:

Chromite	$FeO.Cr_2O_3$
Spinel	$MgO.Al_2O_3$
Picotite	$(Mg,Fe)O.(Al,Fe,Cr)_2O_3$. Contains up to 10% Cr_2O_3
Magnetite	$FeO.Fe_2O_3$
Magnesio ferrite	$MgO.Fe_2O_3$

[1] See Figure 1

[2] From publications of the United States Geological Survey

Theoretically chromite should contain 67.9% Cr_2O_3 and 32.1% FeO. However, even the purest specimens free from gangue rarely contain over 60% Cr_2O_3 and ores containing 35% or less are common.[1] The diversity of composition may be explained by the fact that chrome ore is really an isomorphous mixture of various minerals of the spinel group in varying proportions, in which FeO may be replaced in part by MgO, and Cr_2O_3 by Al_2O_3 and Fe_2O_3. Such isomorphous mixtures cannot be brought to a higher grade by any mechanical process of concentration. Certain ores contain as much as 11% to 17% MgO, and 20% to 26% Al_2O_3, and hence include in their composition a considerable proportion of the normal spinel molecule.

An interesting study of the molecular composition of Maryland chrome sands has been made by J. T. Singewald, Jr.[2] Two samples of the chrome sand gave the following results after separation into magnetic and non-magnetic portions:

		Per cent of	Molecular percentages			
		Total	$MgO.Al_2O_3$	$FeO.Al_2O_3$	$FeO.Cr_2O_3$	$FeO.Fe_2O_3(Fe_3O_4)$
Sample A	Magnetic	56.5	16	4	31	49
	Non-magnetic	43.5	19	20	52	9
Sample B	Magnetic	5.9	0	8	3	89
	Non-magnetic	94.1	19	45	10	26

The gangue minerals which most frequently occur in chrome ore are olivine, talc, chlorite, and serpentine. Fissures of magnesite, or silica in the forms of quartz, chalcedony or opal are not uncommon. A considerable proportion of the gangue minerals can often be removed from chromite by suitable processes of concentration.

Physical Properties

Chromite is opaque, brownish black to iron-black, with a dark brown to grayish brown streak, and a metallic or submetallic luster. It has a hardness of 5.5 and a specific gravity of 4.3% to 4.5%, being lighter than magnetite, which has a specific gravity of 5.17 to 5.18. It has no cleavage, is brittle, has uneven fracture, and sometimes is feebly magnetic.

Chromite crystallizes in the isometric system, usually in octahedrons. The crystals, however, are generally of microscopic size, and the ores have a massive appearance, being either granular or compact. The melting point of a chromite ore, the analysis of which is not stated, is given by Kanolt as 2180°C.[3]

[1] Knopf and Lewis, "Chrome Ores in Maryland, Pennsylvania and North Carolina," U. S. Geol. Surv., *Bull.* **725B,** 117 (1921).

[2] Joseph T. Singewald, Jr., "Maryland Chrome Sand Ore," *Econ. Geol.*, **14,** 189 (1919); *Chem. Abs.*, **13,** 1692 (1919).

[3] C. W. Kanolt, "Melting Points of Firebrick," U. S. Bur. Standards, *Tech. Paper* **10,** 15(1912); *Jour. Gas Lighting*, **119,** 503 (1913); *Jour. Franklin Inst.*, **174,** 225 (1912); *Trans. Amer. Electrochem. Soc.*, **22,** 95 (1912).

Chrome ores are variable in appearance, and the quality cannot safely be judged by visual examination. California ores containing 50% to 55% Cr_2O_3 are usually fine-grained and brittle, resembling anthracite; 40% to 44% ores have the appearance of dull graphite; 35% ores often have a rusty color.[1] However, certain heavy black ores which appear to the eye to be of excellent quality, are low in Cr_2O_3 and contain considerable magnetite. On the other hand good ore may sometimes be thought high in silica, if, as sometimes happens, it is coated with a film of $MgCO_3$ which gives it a white appearance.

Singewald[2] has pointed out that field determinations based upon the magnetic properties of chromites may lead to error. A non-magnetic mineral resembling chrome ore in the field, may be a black spinel, with a comparatively low percentage of Cr_2O_3; while a strongly magnetic mineral may be chrome ore of fair grade, but with an appreciable amount of Fe_3O_4.

Chemical Properties

Of all the common refractories, chromite is the most nearly neutral in its chemical behavior. It is acted upon, however, by either strong acids or by strong bases, being less resistant to the latter than to strong acids.

Chromite is decomposed by fusion with potassium and sodium bisulphate. In an oxidizing atmosphere it is attacked at high temperatures by potash, soda or lime, with the formation of chromates and dichromates. By being mixed with soda and silica it can be fused even without an oxidizing agent. At high temperatures carbon has a reducing effect upon chromite forming an alloy of Fe, Cr and C known as ferro-chrome.

The fusibility curve has been determined for mixtures of Zettlitz kaolin and chrome ore.[3] The ore used contained 52.9% Cr_2O_3, 22.6 FeO, 4.8 Al_2O_3, 9.6 SiO_2 and 10.0% MgO, and had a melting point of about 2000°C. The melting point of the mixtures decreased rapidly until a eutectic was reached at about 1435°C for 35% kaolin. Above this the curve rose again to the melting point of kaolin, with another irregularity at 70% kaolin. (See Fig. 2.)

Occurrence

Chromite deposits are found chiefly in basic igneous rocks, peridotite and the serpentine derived from it. To a minor extent chromite occurs in residual clays, and in beach and stream sands, which have resulted from the concentration of particles derived from the weathering of serpentine.

[1] Harold French, "Manufacture of Chromates from Chromite," *Min. Sci. Press*, **113**, 845 (1916); *Chem. Abs.*, **11**, 385 (1917).

[2] Joseph T. Singewald, Jr., *ibid.*

[3] M. Simonis, "The Use of Chromite as a Refractory Material," *Stahl u. Eisen*, **28**, 334 (1908); *Eng. Min. Jour.*, **59**, 154 (1919); *Chem. Abs.*, **2**, 1685 (1908).

In the primary deposits it does not occur in well-defined veins, but is found in lenticular bodies, usually much longer than broad; in irregular masses or pockets which seem to have no relation to each other, or in stringers and disseminated grains. The ore bodies vary in size from small nodules to masses containing many thousand tons.[1] The largest body mined within

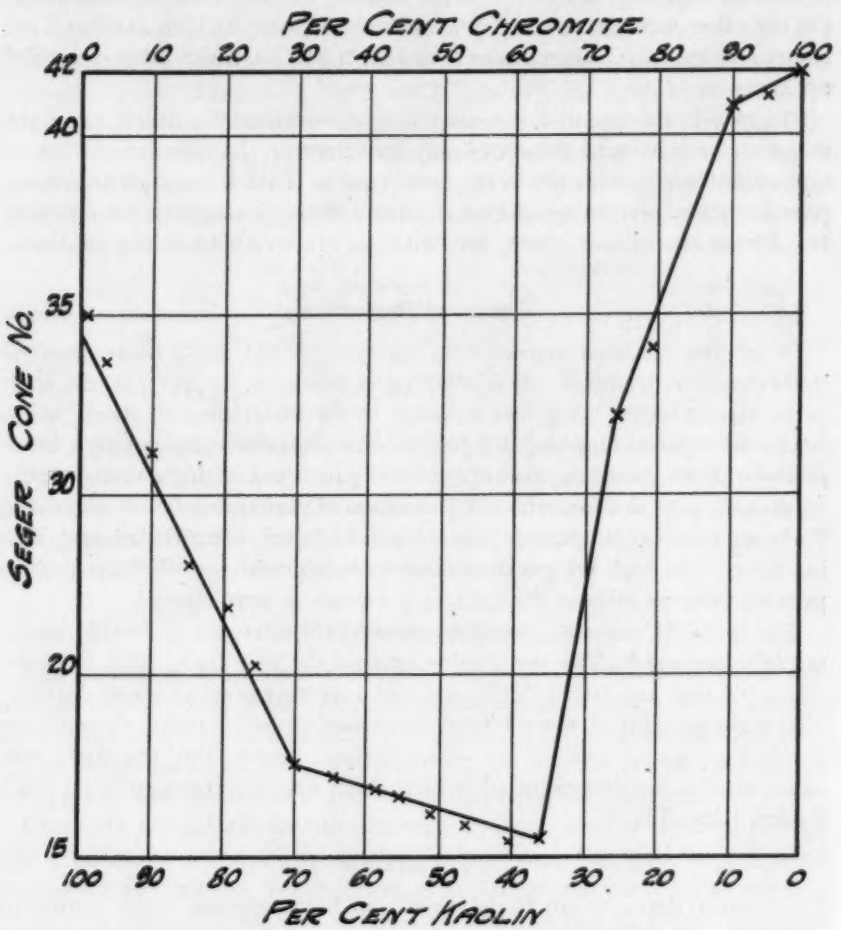


FIG. 2.—The fusion points of mixtures of chromite and kaolin.[2]

recent years in the United States was the Castle Crag Mine in Shasta Co., California; it was 150 feet long, 40 feet wide, 54 feet deep and produced 12,000 tons of commercial ore. It is estimated that the average chromite

[1] Diller, Westgate and Pardee, "Deposits of Chromite in California, Oregon, Washington and Montana," U. S. Geol. Surv., *Bull.* **725A**, 10 (1921).

[2] *Trans. Amer. Inst. Mining Eng.*, **59**, 154 (1918).

content of the ore-bodies mined in California and Oregon during the war was about 50 tons. These bodies are very small compared with the deposits of New Caledonia and Rhodesia.

Chromite is regarded as one of the primary constituents of igneous magmas rich in iron and magnesia; the ore-bodies were formed through segregation during cooling and consolidation of the molten mass. It is believed that the chromite was one of the first minerals to separate out when the mass began to cool. The longer it remained in solution the less opportunity there was for the formation of distinct bodies, for as the magma began to lose its fluidity the chromite separated out into smaller bunches or in grains scattered throughout the enclosing rock.[1]

Chrome ore liberated by rock weathering and decay may be found at the surface, hence scattered surface boulders are not necessarily an indication of the existence of an ore-body below.[2] On account of the pockety nature of the deposits, mining is subject to great uncertainty and risk. As a rule, no estimate can be made of the amount of chrome in a deposit beyond what is actually proved.

Waste rock may be removed from chrome ore by hand-cobbing, and by mechanical concentration. In the latter case, the ore may be crushed, treated in classifiers and fed to concentrating tables.

Deposits and Production

Chromite deposits occur in many parts of the world, notably Rhodesia, New Caledonia, Turkey, India, Greece, Canada, Cuba and Brazil. In the United States chrome occurs in California, Oregon, Wyoming, Alaska, North Carolina, Maryland and Pennsylvania.

From 1827 until the beginning of the Civil War, most of the world's supply of chrome came from the Baltimore area, Maryland, and Lancaster Co., Pennsylvania.[3] The Wood mine, in Lancaster Co., was an operation in a deposit of remarkable size. It was opened in 1828 and operated for nearly 50 years, producing about 95,000 tons of ore. The ore body had a maximum length of 300 feet and a depth of about 720 feet; its width averaged 20 feet. Chrome mining in this region ceased at some time in the late seventies or early eighties, due to the development of the Turkish deposits.

From about 1880 to 1900 large quantities of chrome were mined from the deposits of Brusa, Asiatic Turkey, which began operations in 1877.

[1] H. Ries, "Chromium, Its Occurrence and Mining," *Eng. Min. Jour.*, **104**, 988 (1917); Waldemar Lindgren, "Mineral Deposits," McGraw-Hill Book Co., Publ. New York (1913).

[2] Knopf and Lewis, *loc. cit.*

[3] Wm. Glenn, "Chrome in the Southern Appalachian Region," *Trans. Am. Inst. Mining Eng.*, **25**, 481 (1895).

These deposits were noted for their size and cheapness of mining. At the present time the important producers of chrome ore are Turkey, New Caledonia, Rhodesia, Greece and Canada.

TABLE II

TYPICAL ANALYSES OF CHROMITE

	1	2	3	4	5	6	7
Cr_2O_3	56.8	48.1	54.5	58.1	42.6	53.1	32.9
FeO	12.1	14.8	19.5	27.6	13.8	15.3	13.0
Al_2O_3	15.0	12.5	11.0	3.8	8.3	8.0	8.3
MgO	14.0	16.5	8.0	3.2	21.1	16.1	24.6
SiO_2	1.5	6.2	3.1	5.1	9.5	6.4	14.0
CaO	0.7	....	1.5	....	....	1.2	....

	8	9	10	11	12	13	14
Cr_2O_3	40.7	33.2	39.5	52.7	34.5	42.5	48.4
FeO	16.6	14.6	15.8	14.2	14.2	15.0	14.4
Al_2O_3	24.3	28.8	26.2	12.5	19.0	16.8	12.1
MgO	14.9	n.d.	15.8	15.5	20.5	16.5	14.2
SiO_2	3.0	6.0	3.0	4.0	11.0	7.5	5.9
CaO	....	....	....	0.5	0.8	0.9	....

1, 2, Asiatic Turkey; 3, 4, New Caledonia; 5, 6, 7, Quebec; 8, Greece; 9, 10, Cuba; 11, 12, 13, California; 14, Rhodesia, South Africa.

The deposits of India, Cuba and Brazil have not been developed to any great extent but are potential sources of supply.

Deposits in the United States.—Chrome ore was first mined in California in 1880, and 2000 to 3000 tons annually were produced until 1895 to 1896. The output from that time until 1913–1914 was negligible. With the stimulus of higher prices during the war, California ores were again exploited, and the output rose to 63,000 tons in 1918. There are two main belts, one in the Klamath Mountains and the Coast Range from Siskiyou Co. to San Luis Obispo Co., the other in the Sierra Nevada Mountains from Plumas to Tulare Co. At places the black sands on the Pacific Coast contain considerable chromite.

Some of the Californian deposits contain up to 55% Cr_2O_3; others run as low as 20% in Cr_2O_3, and as high as 20% in SiO_2. Some of this is of such a nature that concentration is possible, and during 1918 and 1919 concentrators were operated at a few places, where the Cr_2O_3 content was brought to 40% or higher. Of the ore produced in the United States in 1918, 24% contained 45% or more Cr_2O_3; 55% contained between 35% and 45%; and 21% carried less than 35% Cr_2O_3.

Chrome is found in Southwestern Oregon, in the vicinity of Grant's Pass, and in the Northeastern part of the state, not far from Baker City. Chrome ore has been found at two points on the Kenai Peninsula, Alaska;

the ore reserves are reported to be about 30,000 tons in the one and 190,000 in the other. About 1000 tons were produced each year in 1917 and 1918.

There are a few small deposits near Burnsville, Democrat and Webster, North Carolina. Near Glenrock, Wyoming, a deposit of chromite has been found and worked on a small scale.

Uses of Chromite in the Metallurgical and Chemical Industries

The most important use of chrome ore is in the manufacture of ferro-chrome, the alloy of chrome and iron. It is usually prepared by direct reduction of the ore in the electric furnace.[1] For this purpose high grade ores are desired. Ferro-chrome usually contains over 60% Cr and .6% to 9.5% C; the physical characteristics of the alloy are governed by the amount of C present.

Ferro-chrome is used in making chrome steels. The amount of chromium in the steel may vary from 1% to 4% and the carbon from .5% to 2%. Chromium raises the elastic limit of the steel, increases the hardness, and intensifies the effect of other alloying elements. Chrome-nickel and chrome-manganese steels are not uncommon. Chrome steels are used for high-speed tools, armor plate, armor-piercing projectiles, crushing machinery, safes and automobile parts.

The principal chemical uses of chromite are in the manufacture of bichromate of soda, bichromate of potash, chromic acid (Cr_2O_3) and chrome alum, which are employed in the manufacture of dyes and pigments and for tanning leather.[2] For chemical purposes high grade ores containing over 50% Cr_2O_3 are desired. Chrome yellow, orange and green are used as dyes; chrome yellow, orange, red and green and Guignet's green, as pigments.

Cr_2O_3 is prepared by the action of a reducing agent upon sodium dichromate at fairly low temperatures. Its melting point is 1990°C.[3] Metallic chromium may be prepared by the reduction of Cr_2O_3 by C in the electric furnace or by the thermit process. It is a very hard, non-magnetic, light green glistening crystalline powder. The specific gravity is 6.8[4] and the melting point 1520°C.[5] It is stated[6] that metallic chromium has been used in the manufacture of high speed tool steel in place of ferro-chrome.

[1] R. J. Anderson, "Metallurgy of Ferrochromium," *Eng. Min. Jour.*, **104**, 245 (1917); Lyon, Keeney and Cullen, "The Electric Furnace in Metallurgical Work," U. S. Bur. Mines, *Bull.* **77**, 127 (1916).

[2] J. S. Diller, "Chromite in 1917," *Mineral Resources of the U. S.*, **34** [1], 37 (1917).

[3] C. W. Kanolt, "The Melting Points of Refractory Materials," *Trans. Amer. Ceram. Soc.*, **15**, 167 (1913).

[4] H. Ries, *ibid.*, **104**, 988 (1917).

[5] G. K. Burgess and R. G. Waltenberg, "Melting Points of the Refractory Elements, I. Elements of Atomic Weight from 48 to 59," U. S. Bur. Standards, *Bull.* **10**, 85 (1914).

[6] J. C. Williams, "Chromite," *Min. Sci. Press*, **117**, 281 (1918).

Manufacture of Chrome Refractories

Foreign Practice.—A. B. Searle[1] has described the European methods of making chrome brick. Ores high in Cr_2O_3 are not generally used. A bonding material such as fire clay or lime is usually added to the pulverized ore; fire clay and kaolin are generally considered satisfactory, but are said to produce brick of lower melting point than those bonded with about 5% of lime. Other bonds which have been used or suggested are plaster of Paris; gypsum; 2% gypsum plus 1% aluminum sulphate; bauxite; 5% to 10% magnesia; 10% to 20% magnesite; 12% dolomite; hot tar; chromium salts, particularly potassium bichromate; various alkaline salts; clay with a little resin, coal or other carbonaceous matter. The purpose of adding the carbonaceous matter was to effect partial reduction of the ore to ferro-chrome.

The pulverized ore and bond are mixed with water in a trough mixer. In molding, a power press may be employed, or the material may be tamped by hand into iron molds. Drying is done slowly on a hot-floor. The brick are commonly, but not always, set in the same kiln with silica brick, and burned to cone 16 (1450°C) or higher.

The brick usually contain about 33% Cr_2O_3, although some grades contain over 60%. In the following analyses given by Searle,[2] brick C is stated to have about the average composition for British brick.

	A	B	C
Cr_2O_3	51.43	62.16	35.87
FeO	35.54	28.02	15.26
Al_2O_3	2.05	2.51	31.28
MgO	3.84	0.82	11.43
SiO_2	1.74	2.42	5.23
CaO	5.27	3.95	0.91

American Practice.—Ores of the following approximate analyses are used in the United States as refractory materials.

	A	B
Cr_2O_3	40.8%	44–48%
FeO	17.8	14
MgO	14.9	15
Al_2O_3	22.4	12
SiO_2	3.7	5 to 8

In the manufacture of brick, the use of any bonding material is not now customary in American practice. For that reason it is essential that the ore used be one which will bond strongly together at kiln temperatures, but without deforming or squeezing out of shape.

[1] Alfred B. Searle, "Refractory Materials," Charles Griffin & Co. Ltd., Pub., London (1917).

[2] Alfred B. Searle, *ibid.*

The ore, after being finely ground in a ball mill, is mixed with a small amount of water to the consistency of damp sand in a wet pan. The brick are molded either in a power press at high pressure or by hand. In the latter case the molds are filled by pounding with heavy plank mauls covered with metal. The brick are dried in tunnel driers. Both in the green and dried condition chrome brick are fragile and must be handled with great care. When set in the kilns for burning, they are boxed in with silica brick in such a way that there is hardly any load upon them and only 4 or 5 bricks are placed in a "box." They are burned in rectangular downdraft kilns, usually with magnesia brick. A burning temperature of cone 18 to 20 or slightly higher is customary; the permanent volume change in burning is negligible. Cooling of the kilns must be done slowly in order to avoid any cracking of the brick.

Properties of Chrome Brick

Properties in General.—The chief value of chrome brick lies in their chemically neutral character and their high refractoriness; their greatest disadvantages are their sensitiveness to rapid thermal change, and their inability to support heavy loads at high temperatures.

Chrome brick are shiny black in color. They are much heavier than fire clay or silica, and slightly heavier than magnesia brick; the weight of a chrome standard 9-inch brick, 9″ x 4½″ x 2½″, is between 10 and 11 pounds, and the bulk specific gravity is, therefore, 3.0 to 3.2.

The melting point of chrome brick, as determined by Kanolt is 2050°C.[1] The same observer found that magnesia brick melt at 2165°C and high-grade clay and silica brick at 1710°C. The analysis of American chrome brick is the same as that of the ore from which it is made. This has been given in the preceding pages.

Crushing Strength.—Chrome brick are very strong in the cold condition, having a crushing strength on flat of 3000 to 5000 pounds per square inch. However, they will not sustain a heavy load at high temperatures. G. H. Brown[2] found that a chrome brick of American manufacture, when set on end and heated, failed suddenly at 1450°C under a load of 50 pounds per square inch. The brick sheared diagonally into two parts, with no previous evidence of contraction. In the experiments of Mellor and Emory[3] a chrome brick under a load of 50 pounds per square inch failed suddenly at 1400°C. Magnesia brick, under the same load, in each case failed at a temperature of about 100°C higher than chrome brick.

[1] C. W. Kanolt, "Melting Points of Fire Brick," U. S. Bur. Standards, *Tech. Paper* **10,** 15 (1912); *Jour. Gas Lighting,* **119,** 503 (1913); *Jour. Franklin Inst.,* **174,** 225 (1912); *Trans. Am. Electrochem. Soc.,* **22,** 95 (1912).

[2] G. H. Brown, "Notes on Load Test made on Magnesia, Chrome and Silica Brick," *Trans. Amer. Ceram. Soc.,* **14,** 391 (1912).

[3] "Effect of Load on the Refractoriness of Fire Brick," *Gas. J.,* **142,** 478 (1918).

The experiments of Bodin[1] indicate that the crushing strength of chrome brick is practically constant from room temperature up to 950°C, falling off rapidly above that point.

Modulus of Rupture.—The cross breaking strength of chrome brick is high for cold brick, but low at high temperatures. The average results of Hartmann and Koehler,[2] who investigated this property at 20° and 1350°C, are given in part below, for the materials which they used.

Material	Modulus of rupture, pounds per square inch	
	20°C	1350°C
Chrome Brick	1390	22
Magnesia Brick	1390	136
Silica Brick	550	161
Fire Brick—Grade A	665	113

Resistance to Abrasion.—Hartmann and Kobler[3] have made comparative abrasion tests on different kinds of refractory materials at ordinary temperatures and at 1350°C. The amount of abrasion was measured by determining the depth abraded in 5 minutes by a carborundum cutting wheel at a constant pressure.

It seems probable that the magnesia and chrome brick used in this test were not of the usual commercial grade, but were of the same quality as those used by Hartmann and co-workers in their study of electrical resistivity.[4] In that event the figures quoted will not apply to the usual magnesia and chrome brick on the market. Moreover, a more accurate method for determining abrasion at 1350°C should have been chosen. The brick were heated on one end, being inserted while cold in the wall of a furnace which had been previously brought to 1350°C, and kept there for two hours. After heating, the brick were removed quickly and while still hot were held for three to five minutes against a cutting wheel. The temperature changes involved in the heating up and testing were too rapid for such materials as chrome, magnesia and silica brick, and undoubtedly caused some cracking and lowered the resistance to abrasion.

The results, in part, are as follows:

Material	Cold Depth of cut, inches 5 Minutes	1350°C Depth of cut, inches 5 Minutes
Chrome Brick	0.07	0.27
Magnesia Brick	.05	12.5
Silica Brick	.17	Spalled
Fire Brick—Grade A	.26	.11

[1] V. Bodin, "Tests on Refractory Products under Load at Different Temperatures," *Trans. Ceram. Soc.* (British), **21** [1], 43(1921–22).

[2] Hartmann and Koehler, "Physical Characteristics of Specialized Refractories, Pt. IV: Cross Breaking Strength 20° and 1350°C," *Trans. Am. Electrochem. Soc.*, **39**, 129 (1921).

[3] Hartmann and Kobler, "Physical Characteristics of Specialized Refractories, Pt. II: Comparative Cold and Hot Abrasion Tests," *ibid.*, **37**, 717 (1920).

[4] See remarks under this heading on p. 877.

Thermal Conductivity.—No accurate studies have been published concerning the thermal conductivity of chrome brick. However, it is known to be considerably higher than that of clay and silica, and slightly lower than that of magnesia brick.

No figures are available concerning the specific heat.

Electrical Resistivity.—Stansfield, MacLeod and McMahon[1] and Hartmann, Sullivan and Allen[2] have compared the resistivity of various refractories at high temperatures.

TABLE III

ELECTRICAL RESISTIVITY IN OHMS PER CM.[3]

Temperature, °C	Chrome brick A	Chrome brick B	Magnesia brick A	Magnesia brick B	Silica brick A	Silica brick B	Fire brick A	Fire brick B
Cold	....	48.1×10^6	....	137×10^6	....	125×10^6	....	137×10^6
600°	....	...	....	....	....	....	21000	....
700°	....	...	....	....	....	....	17000	....
800°	2800	803	....	5.00×10^6	....	2.38×10^6	13000	57600
900°	760	525	....	1.24×10^6	....	765000	9000	20600
1000°	420	171	....	708000	....	300000	6600	10800
1100°	430	78	....	560000	....	126000	4400	6590
1200°	450	63	....	193000	....	62000	2300	4160
1300°	410	77	6200	67400	9700	30900	1300	2460
1400°	320	85	420	22400	2400	16500	690	1420
1500°	....	41	55	2500	710	8420	280	890
1550°	....	...	30	....	22	....	60	....
1565°	....	...	25	....	18	....	....	....

A—Stansfield, MacLeod and McMahon.

B—Hartmann, Sullivan and Allen; figures are for ascending temperatures.

The chemical analyses of the brick studied by Hartmann and co-workers are given as follows:

	Chrome brick	Magnesia brick	Silica brick	Fire brick
SiO_2	15.8	6.0	94.8	50.4
Fe_2O_3	....	0.3	0.2	0.8
FeO	13.2	....	....	....
Al_2O_3	7.3	6.3	1.8	45.5
CaO	....	3.1	2.4	0.5
MgO	18.5	84.1	0.3	0.8
TiO_2	....	....	....	1.9
Cr_2O_3	40.9	....	....	....

It will be observed that the results obtained by the two groups of workers are far from agreement. Stansfield, MacLeod and McMahon have indicated that the probable error of their determinations is less than 5% or 10%

[1] A. Stansfield, D. L. McLeod and J. W. McMahon, "Electrical Resistance of Fire Bricks at High Temperatures," *Trans. Amer. Electrochem. Soc.*, **22**, 89 (1912); *Met. Chem. Eng.*, **10**, 746 (1912).

[2] Hartmann, Sullivan and Allen, "Physical Characteristics of Specialized Refractories, Pt. III: Electric Resistivity at High Temperatures," *Trans. Amer. Electrochem. Soc.*, **38**, 279 (1920).

for reading under 6,000 ohms, rising to a maximum probable error of 25% at 21,000 ohms; also that the results for chrome brick are subject to correction. Hartmann, Sullivan and Allen state that their results cannot be regarded as average values, on account of differences in different specimens of brick, but that they serve to indicate the relative order of magnitude of the electrical resistivities up to 1500°C. They have shown that for some refractories there is a considerable change in resistivity with time of heating.

The analyses indicate that the tests of Hartmann and co-workers were not made upon chrome and magnesia brick of the grade generally used commercially. The chrome brick, for example, contained 15.8% SiO_2 and 7.3% Al_2O_3, which are not typical and the magnesia brick contained only .3% Fe_2O_3 instead of the customary 6.5%.

Effect of Temperature Changes.—At furnace temperatures, the thermal expansion of chrome brick is approximately .20″ per foot. When subjected to rapid temperature changes chrome brick have a tendency to crack and pieces may spall off. Furnaces in which chrome brick are used should be heated slowly and carefully.

Chemical Behavior.—The most useful property of chrome brick is their nearly neutral chemical character, which renders them highly resistant to the action of the usual metallurgical slags, either acid or basic. One of their most common uses is the separation of other refractory materials which react chemically with each other at high temperatures.

Molten silica has a fluxing action upon chrome brick, and carbon has a reducing effect at high temperatures. However, unlike carbon, chrome may be exposed to either an oxidizing or a reducing furnace atmosphere without injury.

Uses of Chrome Refractories

Steel Industry.—In the basic open hearth furnace, the use of chrome brick to separate the acid and basic portions of the refractory structure is undoubtedly good practice. A course of chrome brick between the silica and magnesia brick in the side walls, and between the clay and magnesia brick in the refractories underlying the working bottom, will prevent chemical reaction between the magnesite and the other refractories. It has been shown that at approximately 2775°F magnesia and fire brick react with the formation of a thin liquid slag. With magnesia and silica brick, the reaction is less violent and appears to begin at about 2900°F.

The open hearth port walls are frequently built of chrome brick, which cut away less rapidly than silica brick, and therefore, keep the port section more nearly uniform.

Lump chrome ore has not been found satisfactory as a bottom material

in the open hearth, but is sometimes employed in building up the slopes or blocks at the ends of the furnace. Spaces between the larger lumps are filled with smaller lumps and finely ground ore, and the surface is daubed over with the fine material. Ground chrome ore is used also for ramming around the tap hole; for patching and daubing around the jambs and ports, and in the paving of the ports; and for daubing on the side walls from the slag line to the top of the walls. This is done in order to protect the walls from corrosive spray. Practice varies considerably; some plants use no ground chrome ore, others as much as 2 to 3 pounds per ton of steel produced. There is a great difference in the serviceability of different grades of chrome ore for this practice.

In soaking pits, heating and heat treating furnaces and certain other furnaces, iron oxide scale is formed which has a strongly corrosive action upon fire brick or silica brick. In the portion of the furnace where this scale collects, chrome brick are frequently used.

In forge and welding furnaces, fire clay brick have a short life, on account of the corrosive action of the iron oxide scale; chrome brick in the bottoms last many months. Chrome brick are superior to magnesia in these furnaces, being less sensitive to rapid temperature changes.

Copper Industry.—In the metallurgy of copper, both chrome ore and brick have been successfully applied as lining materials in blast furnaces, settlers, matte reverberatories, and refining furnaces.

Blast Furnace.—The blast furnace crucible is generally made of fire brick, although with a very corrosive matte, low in copper, chrome brick are considered an economy.[1] In 1901 Wm. Glenn reported the successful use of chrome ore in the crucible hearth. A 12-inch bottom was built up of chrome ore lumps and fines; above this a course of fire brick was laid on end, giving a depth of 8″ to be dissolved before the matte reached the chrome. At the end of two years the bottom was reported to be still in good condition.[2] Chrome brick have been used in the blast furnace hearths at Douglas, Arizona,[3] and in the plant of the Mond Nickel Co., Conniston, Ontario. At Conniston the chrome lining is 25 inches thick.[4]

Settlers.—It has been reported that chrome brick in the blast furnace settlers, or fore-hearths, last two years at the Douglas plant. The method of lining the settler used at Cananea in 1908 has given exceptionally good results.[5] The bottom consists of 10 inches of fire brick throughout, except

[1] H. O. Hofman, "Metallurgy of Copper," McGraw-Hill (1914).

[2] Wm. Glenn, "Chromite as a Hearth Lining for a Furnace Smelting Copper Ore," *Trans. Amer. Inst. Min. Eng.*, **31**, 374 (1901).

[3] F. R. Pyne, "Notes on the Disadvantages of Chrome Brick in Copper Reverberatory Furnaces," *ibid.*, **59**, 151 (1918); *Met. Chem. Eng.*, **18**, 20 (1918); *Min. Sci. Press*, **46**, 60 (1918).

[4] "New Smelting Works of the Mond Nickel Co.," *Eng. Min. Jour.*, **98**, 1050 (1914).

[5] Charles Shelby, "The Cananea Blast Furnace," *Ibid.*, **85**, 841 (1908).

for a $2^1/_2$-inch paving of chrome brick in small areas beneath the spout and around the tap hole. A 9-inch thickness of chrome brick in the side walls is backed up by a mixture of crushed quartz and clay, called "converter lining." The function of the "converter lining" is to decrease loss of heat by conduction and to diminish strains on the steel shell by taking up the expansion of the brick.

In lining the settlers at one of the western smelters, a 9-inch wall of inexpensive clay brick is first built within the shell, leaving an open space between the brickwork and the shell. This space is 6 inches wide at the top and 14 inches wide at the bottom. Upon completion of the brick wall, the open space is tamped full of chrome ore, ground to pass a 4-mesh screen. After the lining has been placed in use, the slag probably eats away the brick lining gradually, but has little effect on the chrome, which sinters solidly together. Settlers lined in this way have been operated many years with no repairs.

B. Magnus[1] reports that blocks of high-grade chrome ore, with a hole drilled through the center, have been used as tapping hole blocks in settlers, with good results both for high and low grade mattes.

At Silverspur, Australia, chrome ore dry masonry has been successfully used for the sidewalls and bottom of a reverberatory furnace producing a highly basic slag. The chromite lumps gradually wore away through the breaking off of small particles. These were too heavy to float on the slag and too light to sink into the matte, and formed a layer of chrome sand between slag and matte. This layer interfered with the working of the furnace as it could not be skimmed out with the slag, nor tapped out with the matte, but had to be skimmed out separately at regular intervals. Difficulties were encountered in the attempt to recover the metal absorbed in the bottoms and skimmed sands.[2]

In matte reverberatory furnaces the use of magnesia or chrome brick along the slag line was at one time common, but this practice was gradually discontinued as side-charging of the furnaces became general. When this method of charging is employed the refractory walls are protected from the action of the corrosive slag by the banks of pulverized ore.

Converters.—Chrome brick have been used to a slight extent in converter linings, although magnesite is the standard refractory for this purpose. Lathe reported in 1910[3] that at the Granby smelter, Anyox, B. C., the converters were lined with chrome brick next to the shell, with

[1] B. Magnus, "Chrome Ore Tapping Blocks for Blast Furnace Settler," *Eng. Min. Jour.*, **101**, 778 (1916).

[2] Edgar Hall, "Chromite Iron Ore as Lining for Reverberatory Furnaces," *Eng. Min. Jour.*, **101**, 267 (1916).

[3] Frank E. Lathe, "Recent Developments at the Granby Smelter," *Canadian Min. Inst.*, **13**, 283 (1910).

magnesia brick only around the tuyeres. At Huaron, Peru, several converters with magnesia linings have chrome brick around the tuyeres.

Refining Furnaces.—For many years chrome brick have been used in refining furnace linings in the Copper Range, Michigan. They are placed around the tap hole and along the slag line for several courses. After about a year's run, the walls are customarily torn down for repairs; the chrome brick are cleaned and the good ones used again.

Francis R. Pyne[1] has reviewed the results obtained from magnesia and chrome brick at an eastern refinery treating very foul blister copper. It was expected that a basic or neutral lining would last longer than silica and decrease the amount of slag formed. Magnesia brick were not sufficiently resistant to the rapid changes in temperature which took place in certain parts of the furnace. Although they withstood the corrosive action of the slag, they cracked and spalled badly. Chrome brick were substituted, and at first seemed to give such good results that they were adopted in all refining furnaces at the plant, both those treating blister copper and those melting cathodes. In a number of furnaces even the silica roofs were replaced by chrome. Eventually, however, it was found that the amount of metal absorbed by the chrome brick was very high. Attempts to recover the values locked up in the scrap ends of chrome brick were not successful. The most satisfactory disposition found for these scrap ends was to grind them up and make them into brick, and thus use them over. There was no difficulty in recovering the values from magnesia brick. Mr. Pyne reached the conclusion that chrome brick are not desirable for refining furnace use, and that magnesia brick should be employed where possible. The difficulty of recovering absorbed metal from chrome had been previously mentioned by Edgar Hall.[2] After considerable experimental work at Silverspur, Australia, it was found that the chrome residues, after being finely ground, could be readily smelted in a lead blast furnace.

At one of the smelters in the Copper Range the construction of the refining furnace roof is unique. Silica brick are laid so as to give a roof $13^1/_2$ inches thick. The joints are made $^3/_{16}$- to $^1/_4$-inch thick and filled with chrome ore ground from 60- to 80-mesh fineness. When laid in this manner the brick resist the corrosive action of the splashing copper much better than when laid in the ordinary way with knife-edge joints. With the ordinary method of laying, corrosive action begins at the joints; these wear back rapidly, leaving the ends of the brick projecting, and giving the arch a "saw-tooth" appearance. With the chrome ore joints there is little if any such action at the joints, and the entire arch wears back evenly and smoothly.

[1] F. R. Pyne, *loc. cit.*

[2] Edgar Hall, *loc. cit.*

Miscellaneous.—Chrome ore and brick have been used with some degree of success in various furnaces in the smelting and refining of lead, antimony, tin and nickel. Chrome is said to offer greater resistance than magnesia to the corrosive action of the oxides of bismuth, antimony, arsenic and tin.[1]

HARBISON-WALKER REFRACTORIES CO.
PITTSBURGH, PA.

BIBLIOGRAPHY

1882

O. T. Tellander, "The Basic Open Hearth Process at the Alexandrowsky Plant, St. Petersburg," *Stahl u. Eisen*, **2,** 599 (1882); *Jour. Iron Steel Inst.*, **22,** 465 (1883).

Ferd. Gautier, "The Dephosphorization of Steel in the Open Hearth at the Alexandrowsky Steel Works near St. Petersburg," *Le Genie Civil*, **3,** 196 (1882).

1885

T. Egleston, "Basic Refractory Materials," *Trans. Am. Inst. Mining Eng.*, **14,** 455 (1885–6).

1886

Ferd. Gautier, "On a Neutral Lining for Metallurgical Furnaces," *Jour. Iron Steel Inst.*, **28,** 151 (1886); *Stahl u. Eisen*, **6,** 504 (1886).

Victor Deshayes, "Iron and Steel Melts Obtained on a Neutral Hearth," *Le Genie Civil*, **10,** 22 (1886).

M. Brustlein, "On Chrome Pig Iron and Steel," *Jour. Iron Steel Inst.*, **28,** 770 (1886).

1887

Dr. Leo, "Manufacture and Uses of Chrome Steel," *Stahl u. Eisen*, **7,** 142 (1887).

"Chrome Ore as a Furnace Lining," *Stahl u. Eisen*, **7,** 27 (1887).

"Swedish Experiments with the Use of Chrome Ore in the Open Hearth," *Stahl u. Eisen*, **7,** 893 (1887).

1888

"Chrome Iron Ore in the Open Hearth," *Jernkontorets Annaler*, **42,** 300(——); *Jour. Iron Steel Inst.*, **32,** 331 (1888).

R. W. E. Macivor, "Chrome Ore in Australasia," *Eng. Min. Jour.*, **45,** 53 (1888).

1889

Odelstjerna, "Chrome Iron Ore Linings in Open Hearth Furnaces," *Jour. Iron Steel Inst.*, **34,** 340 (1889).

1890

"Chrome Iron Ore Linings," *Jour. Iron Steel Inst.*, **36,** 217 (1890).

Ibid., **37,** 783 (1890).

H. Portter, "Chrome Ore as a Basic Lining," *Iron Age*, **45,** 301 (1890).

"Chrome Ore Linings," *Iron Age*, **45,** 140 (1890).

[1] M. Simonis, *ibid;* F. T. Havard, "Refractories and Furnaces," McGraw-Hill Book Co., Pub. (1912); F. T. Havard, "Recent Development in the Refractory Industry," *Trans. Amer. Ceram. Soc.*, **14,** 480 (1912); "Effect of Load on the Refractoriness of Fire Bricks, *Gas. Jour.*, **142,** 478 (1918).

1891

Dr. Lundstrom, "Chrome Iron Ore Linings," *Jour. Iron Steel Inst.*, **39,** 276 (1891).

Dr. Leo, "Chrome and Magnesite Brick," *Stahl u. Eisen,* **11,** 643 (1891); *Jour. Iron Steel Inst.*, **40,** 165 (1891).

1892

A. Dana, "A System of Mineralogy," *Scientific Press Pub.*, **1892.**

1893

"Chrome Cement from Silesian Chrome Ore," *Stahl u. Eisen,* **13,** 399 (1893); *Jour. Iron Steel Inst.*, **44,** 470 (1893).

H. G. Shaw, "Chrome Iron Ore," *Mineral Industry,* **2,** 149 (1893); *Jour. Iron Steel Inst.*, **46,** 288 (1894).

1894

"Chrome Iron Ore," *Mineral Industry,* **3,** 121 (1894).

1895

Wm. Glenn, "Chrome in the Southern Appalachian Region," *Trans. Amer. Inst. Mining Eng.*, **25,** 481 (1895).

P. Speier, "Chrome Ore Furnace Lining," *Echodes Mines,* **21,** 584 (1895); *Jour. Iron Steel Inst.*, **48,** 506 (1895).

"Chromium," *Mineral Industry,* **4,** 91 (1895); *Jour. Iron Steel Inst.*, **50,** 282 (1896).

1896

Matthew Penhale, "Chrome Iron Ore in Quebec," *Mineral Industry,* **5,** 124 (1896); *Jour. Iron Steel Inst.*, **52,** 303 (1897).

1897

Geo. W. Maynard, "The Chromite Deposits on Port-au-Port Bay, Newfoundland," *Trans. Amer. Inst. Min. Eng.*, **27,** 283 (1897).

1898

A. McKay, "Chrome Ore in New Zealand," *Eng. Min. Jour.*, **65,** 190 (1898).

1899

J. H. Pratt, "The Occurrence, Origin and Chemical Composition of Chromite," *Trans. Amer. Inst. Min. Eng.*, **29,** 17 (1899).

1900

J. H. Pratt, "Chromite in North Carolina," *Eng. Min. Jour.* **70,** 190 (1900); *Jour. Iron Steel Inst.*, **58,** 417 (1900).

"Chromium and Chrome Ore," *Mineral Industry,* **8,** 86 (1900).

1901

Wm. Glenn, "Chromite as a Hearth Lining for a Furance Smelting Copper Ore," *Trans. Amer. Inst. Min. Eng.*, **31,** 374 (1901).

"Chrome Iron Ore in Greece," *Jour. Iron Steel Inst.*, **59,** 346 (1901).

"Chromium and Chrome Ore," *Mineral Industry,* **9,** 83 (1901).

1902

R. W. Lane, "Chrome in Turkey," *Eng. Min. Jour.*, **74,** 275 (1902).

"Chromium and Chrome Ore," *Mineral Industry,* **10,** 96 (1902).

1904

"Chrome Ore Supplies," *Eng. Min. Jour.*, **78**, 543 (1904).

P. L. T. Heroult, "The Electrometallurgy of Iron and Steel," *Trans. Amer. Electrochem. Soc.*, **6**, 129 (1904).

1905

Pratt and Lewis, "Corundum and Peridotites of Western North Carolina," *North Carolina Geol. Surv.*, **1**, 369 (1905).

Westinghouse, "A Valuable Refractory Lining," *Eng. Min. Jour.*, **79**, 367 (1905).

Jean Bach, "Manufacture of Refractory Materials from Chrome Ore," German Patent 154,750, *Stahl u. Eisen*, **25**, 231 (1905).

Gustave Gin, "New Gin Process for the Electrical Manufacture of Steel," *Trans. Amer. Electrochem. Soc.*, **8**, 105 (1905).

1908

M. Simonis, "The Use of Chromite as a Refractory Material," *Stahl u. Eisen*, **28**, 334 (1908); *Chem. Abs.*, **2**, 1685 (1908).

F. T. Havard, "Chrome and Magnesite as Basic Refractories," *Eng. Min. Jour.* **86**, 802 (1908); *Met. Chem. Eng.*, **6**, 504 (1908).

E. L. Harris, "Chrome Ore in Asia Minor," *Eng. Min. Jour.*, **85**, 1088 (1908).

Charles Shelby, "The Cananea Blast Furnace," *Eng. Min. Jour.* **85**, 841 (1908).

1909

Herr Simons, "Chromite for Firebrick," *Eng. Digest*, March, 285 (1909).

Robert Tripmacher, "Binding Refractory Substances, as Chromite, for Furnace Linings," U. S. Patent 930,575 (Aug. 10, 1909); *Chem. Abs.*, **3**, 2552 (1909).

S. Wologdine and A. L. Queneau, "Heat Conductivity of Refractory Materials," *Electrochem. and Met. Ind.*, **7**, 383–433 (1909); *Elec. World*, **54**, 626 (1909).

E. C. Harder, "Some Chromite Deposits of Western and Central California," U. S. Geol. Surv., *Bull.* **430** (1909).

1910

Frank E. Lathe, "Recent Developments at the Granby Smelter," *Canadian Min. Inst.*, **13**, 283 (1910).

Geo. P. Merrill, "The Non-Metallic Minerals" (p. 114), John Wiley & Sons, Pub., London (1910).

1911

"Distribution and Utilization of Chrome Ore," *Min. World*, **34**, 883 (1911).

"Chrome Ore Production," *Mineral Industry*, **19**, 102 (1911).

Ruff and Goecks, "Melting and Vaporization of the So-called Highly Refractory Materials," *Zeit. f. Angew. Ch.*, **24**, 1459 (1911).

Alfred B. Searle, "Modern Brickmaking," Scott, Greenwood & Son, Pub., London (1911).

1912

G. H. Brown, "Notes on Load Tests made on Magnesia, Chrome and Silica Brick," *Trans. Amer. Ceram. Soc.*, **14**, 391 (1912).

"A Study of the Open Hearth," Harbison-Walker Refractories Co., Pub., Pittsburgh, Pa. (1912).

F. T. Havard, "Refractories and Furnaces," McGraw-Hill Book Co., Pub., New York City (1912).

A. Stansfield, D. L. McLeod and J. W. McMahon, "Electrical Resistance of Fire Bricks at High Temperatures," *Trans. Amer. Electrochem. Soc.*, **22**, 89 (1912); *Met. Chem. Eng.*, **10**, 746 (1912).

C. W. Kanolt, "Melting Points of Fire Brick," U. S. Bur. of Standards, *Tech. Paper* **10** (1912); *Jour. Gas Lighting*, **119**, 503 (1913); *Jour. Franklin Inst.*, **174**, 225 (1912); *Trans. Am. Electrochem. Soc.*, **22**, 95 (1912).

W. C. Phalen, "Prospecting for Chrome Ore," *Min. Sci. Press*, **105**, 400 (1912).

F. T. Havard, "Recent Developments in the Refractories Industry," *Trans. Amer. Ceram. Soc.*, **14**, 480 (1912).

A. Mankan, "Bricks and Refractory Products Cemented by Spinel," *Ceramique*, **14**, 172 (1912); *Chem. Abs.*, **7**, 689 (1913).

C. A. Mankan, "Refractory Bricks of Spinel," *Ceramique*, **16**, 84 (1913); *Chem. Abs.*, **7**, 2844 (1913).

1913

C. W. Kanolt, "The Melting Points of Refractory Materials," *Trans. Amer. Ceram. Soc.*, **15**, 167 (1913).

1914

"New Smelting Works of the Mond Nickel Co.," *Eng. Min. Jour.*, **98**, 1050 (1914).

H. O. Hofman, "Metallurgy of Copper," McGraw-Hill, Pub., New York (1914).

G. K. Burgess and R. G. Waltenburg, "Melting Point of the Refractory Elements. I. Elements of Atomic Weight from 48 to 59." U. S. Bur. Standards, *Bull.* **10** (1914).

1915

Olaf Peterson, "Materials Adapted for Lining Electric Furnaces," *Min. Eng. World*, **43**, 695 (1915).

A. D. Williams, "Fire Brick for Boiler Furnaces," *Power*, **41**, 297 (1915).

J. S. Diller, "Chromic Iron Ore in 1915," *Mineral Resources of the U. S. 1915.*

"Chromium," *Mineral Industry*, **23**, 92 (1915).

"Geology and Mineral Resources of Kenai Peninsula, Alaska," U. S. Geol. Surv., *Bull.* **587** (1915).

1916

Harold French, "Manufacture of Chromates from Chromite," *Min. Sci. Press*, **113**, 845 (1916); *Chem. Abs.*, **11**, 388 (1917).

B. Magnus, "Chrome Ore Tapping Blocks for Blast Furnace Settlers," *Eng. Min. Jour.*, **101**, 778 (1916).

Edgar Hall, "Chromite Iron Ore as Lining for Reverberatory Furnaces," *Eng. Min. Jour.*, **101**, 267 (1916).

J. S. Diller, "Chromite in 1916," *Mineral Resources of the U. S. 1916.*

Lyon, Keeney and Cullen, "The Electric Furnace in Metallurgical Work," U. S. Bur. Mines, *Bull.* **77**, 1916.

1917

"Chromium and Chromiferous Iron Ores," *Engineering* (London), **103**, 30 (1917).

H. Ries, "Chromium, its Occurrence and Mining," *Eng. Min. Jour.*, **104**, 988 (1917).

R. J. Anderson, "Metallurgy of Ferrochromium," *Eng. Min. Jour.*, **104**, 245 (1917).

S. H. Dolbear, "The Nature of Chromic Iron Deposits," *Min. Sci. Press*, **114**, 552 (1917).

John B. Platts, "The Nature of Chromic Iron Deposits," *Min. Sci. Press*, **114**, 872 (1917).

Fletcher Hamilton, "California Mineral Production for 1917," Cal. State Min. Bur., *Bull.* **83** (1917).

J. S. Diller, "Chromite in 1917," *Mineral Resources of the U. S. 1917.*

Samuel H. Dolbear, "Chromium," *Mineral Industry*, **25**, 100 (1917).

Alfred B. Searle, "Refractory Materials," Charles Griffin & Co., Ltd., Pub., London (1917).

"Refractory Composition," Canadian Patent 180,678 (1917).

W. P. Lass, "Chrome Deposits of Alaska," *Min. Sci. Press*, **115,** 653 (1917).

"Chrome Brick Bushing for Water-Cooled Copper Breast Jackets," *Eng. Min. Jour.*, **104,** 680 (1917).

1918

"Chrome Ore Specifications and Producers of Chromite in California," Cal. State Min. Bur., *Prelim. Rep.*, **3,** San Francisco; *Eng. Min. J.*, **105,** 420 (1918).

"Chrome Ore in Cuba," *Eng. Min. Jour.*, **106,** 617 (1918).

J. C. Williams, "Chromite," *Min. Sci. Press*, **117,** 281 (1918).

"Notes on the Disadvantages of Chrome Bricks in Copper Reverberatory Furnaces," *Trans. Amer. Inst. Min. Eng.*, **59,** 151 (1918); *Met. Chem. Eng.*, **18,** 20 (1918); *Min. Sci. Press*, **116,** 60 (1918).

Fletcher Hamilton, "Chromite," Cal. State Min. Bur., *Bull.* **86** (1919).

"Cuba's Chrome and Manganese Ores," *Iron Trade Review*, **63,** 1238 (1918).

J. S. Diller, "Chromite in 1918," *Mineral Resources of the U. S. 1918.*

W. C. Riddell and Esther Kittredge, "Determination of Chromic Oxide in Chromite," *Min. Sci. Press*, **116,** 558 (1918).

J. S. Diller, "Chromite," U. S. Geol. Surv., *Bull.* **666A.**

Samuel H. Dolbear, "Chromium," *Mineral Industry*, **26,** 88 (1918).

Wm. M. Barr, "Melting Points of Firebricks," *Eng. Min. Jour.*, **105,** 22 (1918).

1919

"Chrome Brick," *Brit. Clayworker*, **28,** 178 (1919); *Chem. Abs.*, **14,** 458 (1920).

"Chrome Mining in Canada," *Eng. Min. Jour.*, **107,** 144 (1919).

Joseph T. Singewald, Jr., "Maryland Chrome Sand Ore," *Econ. Geol.*, **14,** 189 (1919).

A. C. Gill, "Preliminary Report on the Chromite of Kenai Peninsula, Alaska," U. S. Geol. Surv., *Bull.* **712D** (1919); *Chem. Abs.*, **14,** 2457 (1920).

J. F. Grugan, "Chrome Sands on the Pacific Coast," *Chem. Met. Eng.*, **20,** 79 (1919); *Jour. Iron Steel Inst.*, **99,** 624 (1919).

N. M. Penzer, "Minerals of Anatolia," *Min. Mag.*, **21,** 218 (1919); *Jour. Iron Steel Inst.*, **101,** 673 (1920).

Waldemar Lindgren, "Mineral Deposits," McGraw-Hill Book Co., Pub., New York, (1919).

Benjamin L. Miller and Joseph T. Singewald, "The Mineral Deposits of South America," McGraw-Hill Book Co., Pub., New York (1919).

J. B. Mertie, Jr., "Chromite Deposits of Alaska," U. S. Geol. Surv., *Bull.* **692** (1919).

1920

Ernest F. Burchard, "Chrome Ore Deposits in Cuba," *Trans. Amer. Inst. Min. Eng.*, **63,** 150 (1920).

J. S. Diller, "Recent Studies of Domestic Chromite Deposits," *Trans. Amer. Inst. Min. Eng.*, **63,** 105 (1920).

S. H. Dolbear, "The Future of Chromite in the United States," *Mining Sci. Press*, **120,** 645 (1920).

V. Bodin, "Strength of Refractories at Different Temperatures," *Ceramique*, **23,** 177 (1920); *Chem. Abs.*, **15,** 425 (1920).

A. Lacroix, "A New Member of the Spinel Group, Chromohercynite, from Madagascar," *Bull. Soc. Franc. Min.*, **43,** 69 (1920); *Chem. Abs.*, **15,** 220 (1920).

A. B. Searle, "Refractory Materials for Chemical Purposes," *Chem. Age* (London), **2,** 684 (1920); **3,** 123 (1920); *Chem. Abs.*, **14,** 3141 (1920).

"Chrome Ore Deposits in North Carolina," *Eng. Min. Jour.*, **109,** 1112 (1920); *Jour. Iron Steel Inst.*, **101,** 674 (1920).

"Refractories for Electric Furnaces," Elec. Fur. Assoc., Pub., Niagara Falls, N. Y. (1920).

Hartmann and Hougen, "Physical Characteristics of Specialized Refractories. Part I, Spalling Losses," *Trans. Amer. Electrochem. Soc.*, **37,** 707 (1920).

Hartmann and Kobler, "Physical Characteristics of Specialized Refractories. Part II, Comparative Cold and Hot Abrasion Tests," *Trans. Amer. Electrochem. Soc.*, **37,** 717 (1920).

Hartmann, Sullivan and Allen, "Physical Characteristics of Specialized Refractories. Part III, Electrical Resistivity at High Temperatures," *Trans. Amer. Electrochem. Soc.*, **38,** 279 (1920).

1921

Horace E. Williams, "Chromite Deposits of Bahia, Brazil," *Eng. Min. Jour.*, **111,** 376 (1921).

Diller, Westgate and Pardee, "Deposits of Chromite in California, Oregon, Washington and Montana," U. S. Geol. Surv., *Bull.* **725A,** 1921.

Knopf and Lewis, "Chrome Ores in Maryland, Pennsylvania and North Carolina," U. S. Geol. Surv., *Bull.* **725B,** 1921.

Hartmann and Koehler, "Physical Characteristics of Specialized Refractories. Part IV, Cross-Breaking Strength at 20° and 1350°C.," *Trans. Amer. Electrochem. Soc.*, **39,** 129 (1921).

COMPARISON OF HOT AND COLD MODULUS OF RUPTURE FOR SILICA BRICK

By E. N. McGee[1]

ABSTRACT

Purpose of the Investigation.—(1) To obtain relative values for the cross-breaking strength of silica brick at temperatures encountered in coke oven practice.

(2) To correlate the hot modulus of rupture test, if possible, with the cold modulus of rupture, or cold crushing test, either of which is cheaper and more easily conducted.

This report gives the method of making the test, difficulties encountered and results obtained. The report shows a comparison of cold crushing, cold modulus of rupture and hot modulus of rupture on a series of silica brick made from special mixes, commercially burned.

Conclusions.—The modulus of rupture of a silica brick at 1350°C is approximately one-third the strength at atmospheric temperature. For this series it averaged from 130 to 189 lbs. per square inch.

Too rapid or eccentric heating up to red heat may cause such weakening of the structure or bond that the brick will break under very low pressure.

Cross-breaking strength decreases as the temperature increases.

Hot modulus of rupture test appears to give results, in most respects, comparable to the cold test, and for routine testing it would seem advisable to use the cold test since it can be made in much shorter time.

Introduction

Silica brick were first introduced in by-product coke oven construction in the United States at Johnstown, Pa., in 1899. The success of this refractory from the beginning was so remarkable that within a few years it became the common practice to use silica brick in nearly all parts of the coke oven block. Clay brick are used only where the temperature requirements are low, where there are repeated rapid temperature fluctuations or as a veneering to absorb temperature changes.

The principal advantage obtained from the use of silica brick lies in the higher temperatures at which the ovens can be operated. This results in a much faster coking rate, and, consequently, a much greater coke tonnage and gas yield. The reason that these results can be obtained is not because silica brick are more refractory than clay brick, for there are many of the latter refractory having a higher fusion point by 50°C or more. Nor can these results be entirely due to the fact that silica brick conduct heat more rapidly than clay brick. The principal characteristic which has made silica brick so valuable to the coke oven industry lies in their ability to carry heavy loads at very high temperatures without deformation or crushing.

The best clay brick show deformation at 1350°C if subjected to a load of 25 pounds per square inch. If supported on other brick, at both ends, seven inches in the clear, and loaded with a five-pound fire brick in the

[1] Refractories Division, St. Louis Meeting, Feb. 28, 1922.

center, and subjected to a temperature of 1450°C, the best clay brick show a bending of from one-fourth to three-eighths of an inch. Silica brick, on the other hand, show no deformation at 1350°C under a load of 50 pounds per square inch, and no bending on any test which has yet been made. In fact, it is undoubtedly true that they would show no deformation at any load, up to the crushing point, or any bending up to the breaking point. These are the deciding factors which have necessitated the use of silica brick in present coke oven practice, where the ovens are operated normally with a flue temperature of 1350°C, and may, under abnormal conditions, reach 1500°C.

Purpose of This Investigation

The cold crushing and cold modulus of rupture tests have served as the standard tests for judging the strength of silica brick and determining their suitability for service in vital parts of coke oven construction. The load which they will carry at the temperature at which ovens are operated has not been considered important because the construction engineer has relied upon the cold tests and found them satisfactory so far as it has been possible to determine. Whether or not the hot and cold strengths of silica brick are comparative is, however, of considerable importance, and is the main reason for this investigation. The second purpose of this investigation is to obtain definite information on the cross-breaking strength of silica brick at temperatures encountered in coke oven practice.

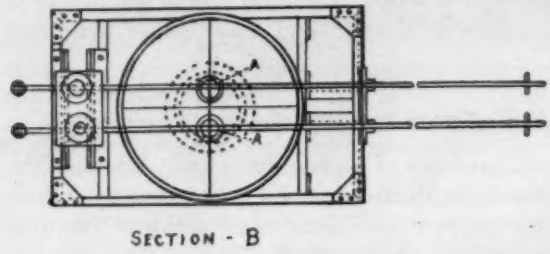
The tests, upon which this investigation is based, were made upon a series of experimental brick obtained from a well-known manufacturer, and since these were special brick, they were consequently as uniform in every way as it was possible to make them. Cold modulus of rupture and cold crushing tests were made at the Mellon Institute of Industrial Research, Pittsburgh, Pa., under the direction of Mr. R. M. Howe. The average of ten samples was taken for each mix of the series. Mr. Howe also attempted to obtain the hot crushing strengths at 1450°C, but furnace conditions prevented this, and we have not as yet obtained satisfactory results for the hot crushing strengths of this series of experimental brick. It is interesting to note that the crushing strength at 1450°C was found to be approximately 300 pounds per square inch.

Description of Apparatus for Hot Modulus of Rupture Test

The hot modulus of rupture tests were conducted at the Refractory Testing Laboratory of the Semet-Solvay Company, Syracuse, N. Y., in a furnace of the design recommended by the American Society for Testing Materials for the testing of refractory materials under load. (Fig. 1.) The tests were conducted at a temperature of 1350°C. This

was found to be a very good working temperature and approximated existing conditions common in oven flue temperatures. The furnace was fired by two tangential 2-inch burners using unpurified coke oven gas.

Two piers (C-C of Fig. 1) were built up from the bottom of the furnace out of carborundum brick so that they were directly under the openings (A-A) in the top of the furnace. These piers reached within 9 inches of the furnace top and were so arched at the bottom that the flame from



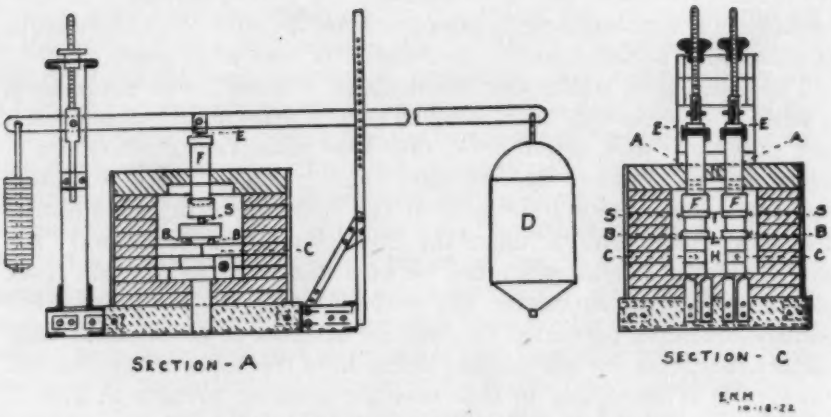


FIG. 1.—Apparatus for hot modulus of rupture test.

the gas burners could pass through and circulate in the interior of the furnace. The two test brick rested on these piers on two pieces of carborundum (B-B) approximating as nearly as possible knife edges and so placed as to make a 6-inch span and have the center of the brick surface come underneath the opening in the furnace cover. A carborundum tube (S-S) (silfrax in this case) 5 inches long was laid across the middle of the brick span and served as the knife edge carrying the pressure. A

large can (D) 18 inches in diameter and 2 feet high, cone-shaped at the bottom, was hung on the end of the beam and gradually filled with water until the brick broke, thus giving, with fair degree of accuracy, the breaking load. The load was conducted to the brick from the beam through a steel knife edge (E), a highly refractory clay cylinder (F) and the carborundum tube (S) mentioned before. The beam was countered-balanced but the other materials formed a part of the breaking load, and their weights were taken into consideration.

Method of Conducting Test

In developing this test considerable difficulty was encountered in heating the test brick from atmospheric temperature to red heat without causing spalling or otherwise injuring the strength of the brick. Since it was necessary to complete the test in eight hours, the heating had to be quite rapid. With the arrangement as described it was found almost impossible to get any good tests. The bricks would usually break at very low pressures, and sometimes even before the temperature reached 1350°C with only the weight of the empty can on the beam. The difficulty of controlling the temperature up to 500°C so as to give a very gradual increase was no doubt the cause of the weakening of the brick. There was no shattering but it appeared that the uneven heating merely weakened the structure.

To correct this condition it was found necessary to fill in between and around the carborundum piers with pieces of carborundum brick and cement, thus dividing the furnace into two compartments (indicated on Section C of Fig. 1); a testing chamber (T) above, and a heating chamber (H) below the brick filling, represented by dotted lines (L). This prevented the flame from playing directly upon the test specimens and made it a much more simple matter to obtain a uniform and consistent increase of temperature in the testing chamber even though there were quite erratic temperature fluctuations in the heating chamber. After making this change, very few inconsistent results were obtained, and those were undoubtedly due to the structure of the brick rather than uneven heating.

Heating Schedule

The following heating was used and proved very satisfactory.

Time		Temperature of testing chamber	Time		Temperature of testing chamber
Hr.	Min.		Hr.	Min.	
0	0	25°C	4	0	700°C
	15	100		15	800
	30	150		30	900
	45	200		45	1000
1	0	230	5	0	1100
	15	260		15	1150

TABLE (*Continued*)

Time Hr.	Min.	Temperature of testing chamber	Time Hr.	Min.	Temperature of testing chamber
	30	300		30	1200
	45	330		45	1250
2	0	360	6	0	1300
	15	400		15	1325
	30	430		30	1350
	45	460		45	1350
3	0	500	7	0	1350
	15	550		15	1350
	30	600		30	1350
	45	650			

Temperature Control

The temperature of the testing chamber was controlled by means of a platinum rhodium thermocouple. The couple and porcelain protection tube were placed in a carborundum (Silfrax) tube and projected about 6 inches into the furnace chamber. The couple connected with a Wilson-Maeulen Tapalog and was equipped with cold end compensating leads. The temperature of the test specimens was also checked occasionally by means of a Leeds and Northrup optical pyrometer. When the temperature reached 1350°C it was maintained about one hour until the bricks were uniformly heated and then the load was gradually increased until the brick broke.

Data

The standard formula $R = \frac{3WL}{2B(d)^2}$ was used for computing the modulus of rupture. The following are the results which were obtained, the letters representing the various brick mixes used in this experimental series:

TABLE I

AVERAGES OF RESULTS OBTAINED

Mix	Cold crushing strength, 9-in. straights	Cold modulus of rupture, 9-in. straights	Hot modulus of rupture, 9-in. straights
A	1650 (1270–2200)	418 (298–486)	167 (162–170)
B	1580 (1320–1910)	449 (349–502)	175 (167–186)
C	1680 (1270–1950)	464 (355–550)	189 (155–229)
D	1360 (1080–1700)	465 (294–626)	180 (167–195)
E	1360 (1150–1760)	435 (317–534)	156 (145–167)
F	1320 (950–1650)	438 (358–586)	156 (143–178)
G	1580 (1040–2090)	486 (298–637)	150 (145–157)
H	950 (640–1240)[1]	462 (336–605)	137 (133–146)
I	990 (640–1240)[1]	404 (209–407)	130 (115–135)

[1] Average of 5 tests instead of 10.

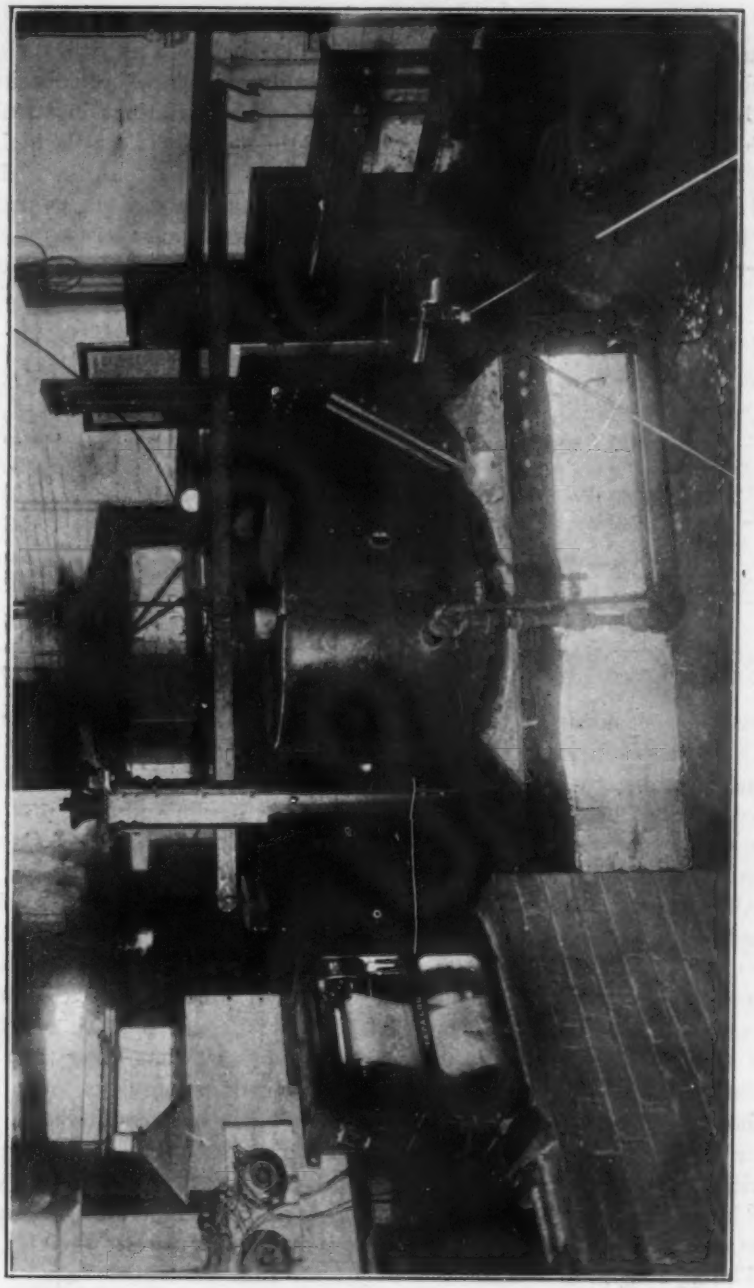


FIG. 2.—Load test furnace—used for hot modulus of rupture test.

Conclusion

In comparing the hot with the cold modulus of rupture test it is difficult to obtain any definite conclusion from the results which have been obtained. Both the hot and cold tests showed considerable variations in strength with the same mix, in fact, in most cases, the difference between the highest and the lowest result in each mix was as great or greater than the highest and lowest of the mix averages. Also in most cases the averages on the hot modulus of rupture are only of three results, and such averages cannot be considered accurate. It will be seen from Table II, however, that with

TABLE II

COLD CRUSHING TESTS

A	B	C	D	E	F	G	H	I
1420	1470	1880	1700	1300	1030	1250	1060	900
1560	1630	1630	1180	1750	1210	2450	1050	1240
1820	1640	1800	1470	1270	950	1580	790	640
1760	1560	1950	1300	1760	1470	2120	800	1180
1730	1360	1670	1080	1280	1220	1360	1030	980
2200	1740	1830	1660	1250	1280	1040	..	..
1560	1320	1490	1380	1290	1170	1560	..	..
1680	1650	1270	1090	1190	1640	1240	..	..
1270	1910	1800	1200	1150	1560	1130	..	..
1470	1530	1440	1580	1400	1650	2090	..	..
Av. 1650	1580	1680	1360	1360	1320	1580	950	990

the exception of mix C, the results were fairly uniform. Results marked with footnote appeared to be inconsistent and consequently it did not seem advisable to take them into consideration. Most of these results were obtained before the change in the furnace design and were probably due either to eccentric loading or too rapid heating, causing a shattering or weakening of the bond.

Although the results as obtained do not permit us to draw any definite conclusion regarding the relation of the hot modulus of rupture to the cold modulus or cold crushing tests, still this investigation does present some interesting and valuable conclusions. It shows, in the first place, that the cross-breaking strength of a brick at 1350°C is approximately one-third the strength at atmospheric temperature, and somewhat lower than had ordinarily been supposed from results obtained on previous load tests, although still considerably higher than should ever be encountered in coke oven practice. Some recent furnace constructions of special design, in which the load was extraordinarily high, have caused crushing of the silica brick, showing that the strength of a brick at high temperatures is an important factor which must be taken into consideration.

The investigation also shows conclusively that silica brick require very uniform and careful heating up to red heat. Erratic heating may cause

TABLE III

MODULUS OF RUPTURE RESULTS—COLD AND HOT TESTS

A		B		C		D		E		F		G		H		I	
Cold	Hot	Cold	Hot	Cold	Hot	Cold	Hot	Cold	Hot	Cold	Hot	Cold	Hot	Cold	Hot	Cold	Hot
445	170	419	186	400	183	505	195	534	167	358	178	618	148	381	146	442	126
349	162	470	172	550	155	554	167	445	145	506	143	637	157	422	140	403	135
374	170	496	167	518	229	556	178	454	156	384	145	557	145	336	133	448	115
298	...	355	338[1]	406	53[1]	294	...	438	110[1]	419	185	502	40[1]	445	52[1]	400	143
448	...	349	72[1]	355	63[1]	416	...	317	42[1]	493	130	419	47[1]	576	...	416	47[1]
467	...	486	...	556	...	576	...	422	...	416	...	298	...	499	...	400	...
448	...	486	...	384	...	371	...	493	...	586	...	467	...	339	...	467	...
486	...	467	...	509	...	429	...	451	...	438	...	320	...	528	...	429	...
445	...	502	...	438	...	626	...	435	...	397	...	592	...	605	...	269	...
...	...	464	...	521	...	320	...	358	...	384	...	451	...	490	...	362	...
418	167	449	175	464	189	465	180	435	156	438	156	486	150	462	137	404	130

[1] Results which appeared irrational and were not considered in computing averages.

such weakening of the structure or bond that the brick will break under very low pressures.

From four tests on samples from this series conducted at temperatures below 1350°C the following results were obtained:

Temperature	Sample	Modulus of rupture
1300°C	"B"	199 lbs. per sq. in.
1300°C	"F"	185 lbs. per sq. in.
1200°C	"C"	289 lbs. per sq. in.
1150°C	"G"	285 lbs. per sq. in.

Comparison of these results with those at 1350°C would seem to indicate that the cross-breaking strength of a silica brick decreases as the temperature increases. Undoubtedly if tests were conducted at temperatures above 1350°C, correspondingly lower results would have been obtained.

The method used in making these hot modulus of rupture tests requires a great deal of time and attention. If such tests were required for determining suitability of brick for certain construction, it would seem advisable to use a rectangular, gas fired furnace of sufficient size and so equipped as to test at least five brick at one time. Ten samples would probably be required to give an accurate average. The furnace would of course have to be uniform in temperature throughout and a much slower heating schedule would give better results, in fact, twenty hours would be about the time required to reach 1350°C, heating at the rate of 50° per hour from 200 to 700°C. This would insure that the strength of the brick would not be affected by erratic heating.

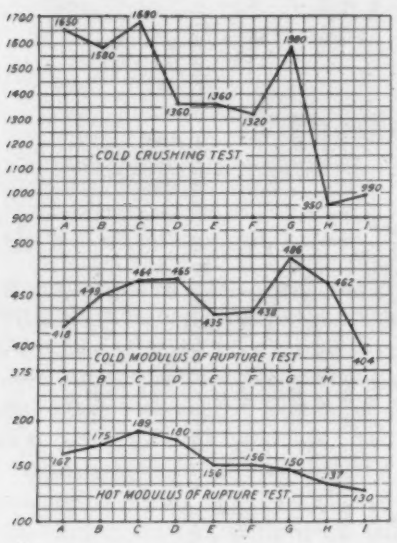


FIG. 3.

The hot modulus of rupture appears, however, as mentioned before, to give results in most respects comparable to the cold test and for routine testing the cold test, which can be made in a much shorter time, would seem to give a fair indication of what can be expected in actual practice.

SEMET-SOLVAY CO.
SYRACUSE, N. Y.

Discussion

Mr. WHITTEN:—I would like to ask the following questions: (1) Has any comparative work been done on silica brick and clay brick, taking into

consideration the fact that the silica brick must still be a sound brick at 1400 or 1500°C? (2) Is there any relationship between the modulus of rupture and the resistance to wear or erosion? (3) How do clay and silica brick check in these respects?

DR. HARVEY:—So far as I know these are the first tests that have been made on hot modulus of rupture of silica brick. For several years a hot transverse test has been made by loading with five pounds weight in the center. If the brick was weak it would break, but ordinarily refractory bricks would simply bend. Mr. McGee and I have discussed the possibility of extending this same series of tests to clay brick, and the question arose as to whether the clay brick would break or simply bend at these operating temperatures. I do not believe that a hot modulus test has been made on clay refractories.

DR. ENDELL:—Mr. Bodin[1] has reported investigations of this sort but I believe his 20 mm. cubes were too small, causing the applied load to be too light. He found the point of decline in resistance, *i. e.*, point where the refractories are in an intermediate, more or less "pasty" state, is at about 1200°C. His exact figures for the different refractories are:

Clay A	1300°C	Bauxite	1100°C
Clay CL	1200°C	Silica bricks	1400°C
Clay P	1100°C	Fused quartz	1400°C
Corundum	1400°C	Magnesia	1000°C

I believe also there is a mistake in his apparatus. It is not possible to test accurately at a pressure of 18 pounds to the square inch. I made this same sort of an investigation, only I put 50 pounds to the square inch, and the temperature of softening was much lower.

MR. GREAVES-WALKER:—Here are the Bodin curves and the line drawing of the apparatus used by Mr. Bodin (Figs. 4 and 5). These curves[2] show that practically all refractories pass their weak stage at various temperatures from cold to their softening point, and practically every kind of refractory, outside of chrome, shows a very erratic curve. For instance, clay brick shows little change up to 800° and then rises rapidly to a strength far above its cold crushing strength and then collapses. The silica curve shows they are weaker at certain points and take on greater strength at 1100 to 1200°; they are even stronger at that point than when they are cold and then they slowly fall.

MR. MCGEE:—We have also the test mentioned by Dr. Harvey, which we call the bending test; the bend takes place at a temperature lower than the usually observed softening point because, we take it, the bricks are more plastic at this lower temperature.

[1] *Trans. Ceram. Soc.* (Eng.), **21** [1], 56 (1921).

[2] See also Schurect, "Note on the Effects of Firing Temperature on Strength of Fire Clay Bodies, **4**, 366(1921).

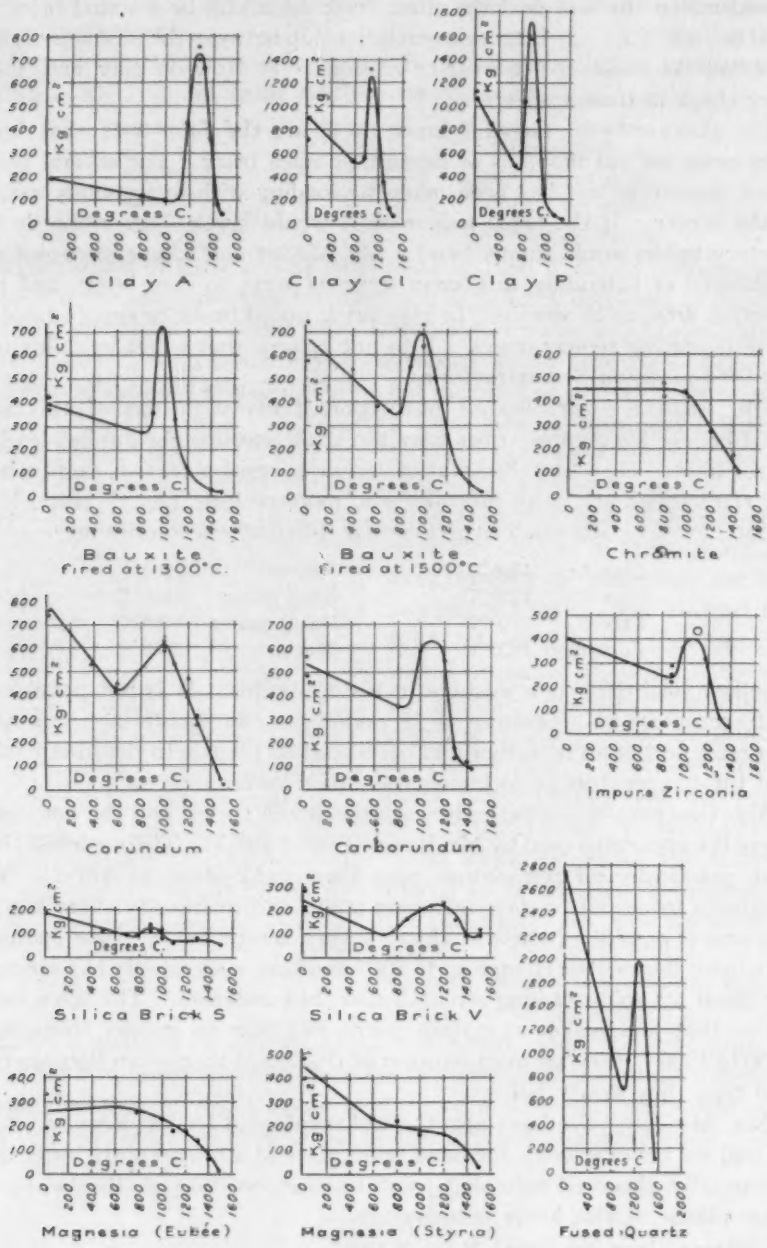

Clay A
Clay Cl
Clay P
Bauxite fired at 1300°C.
Bauxite fired at 1500°C
Chromite
Corundum
Carborundum
Impure Zirconia
Silica Brick S
Silica Brick V
Magnesia (Eubée)
Magnesia (Styria)
Fused Quartz
Degrees C.
Kg/cm²

FIG. 4.

MR. HULL:—We have at the Bureau a very definite problem in connection with certain processes that our Chemistry Division is trying to work out, in which the processes could be very greatly improved if they could

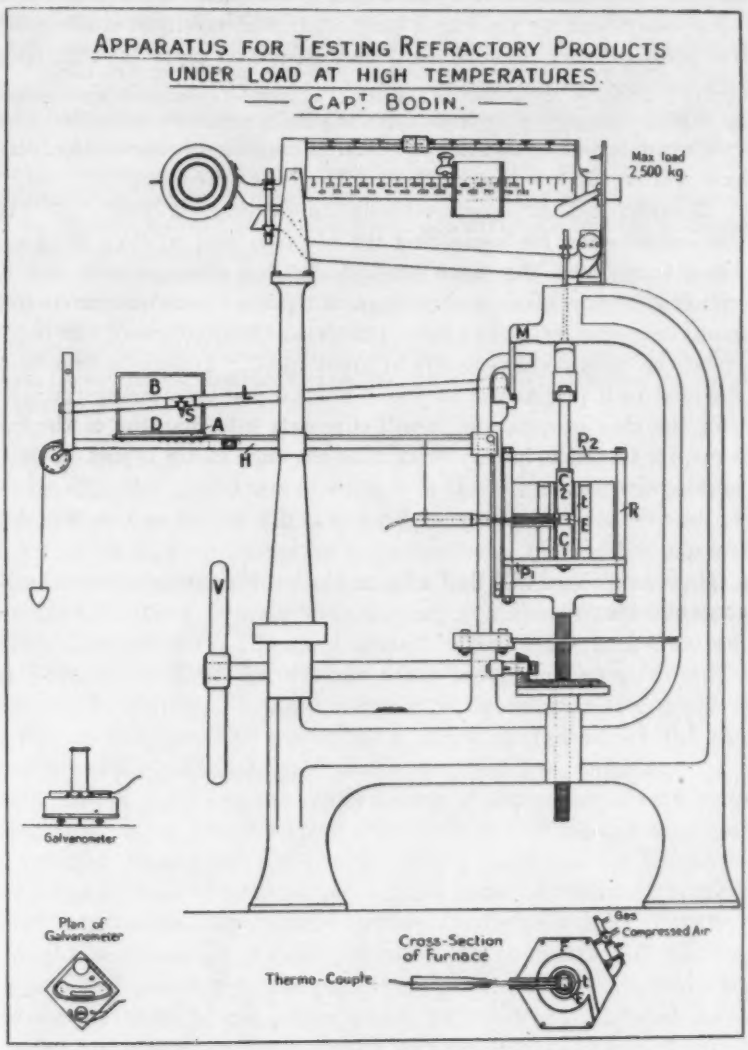


FIG. 5.

find a refractory which could withstand a pressure of 25 pounds per square inch at a temperature of 1600°C. If they could get one which would stand 1700°C, they would have a very great increase in efficiency, but we are still looking for one which will stand 1600°C. It may be

that here the same rule applies, *i. e.*, some of the bricks that we have difficulty getting up to 1600°C might stand more at higher temperatures.

MR. GREAVES-WALKER:—These curves would seem to show that that is the case, but the difficulty they have had in hot blast stoves, for instance, has been eliminated by finding a brick that had strength enough at its weakest point to carry the load until they passed on up to the temperature at which the stove was operating.

MR. HULL:—It just occurs to me that if this is true with the special refractories we have been testing it would be feasible to reverse the furnace and heat it from the top down instead of from the bottom up.

DR. HARVEY:—This is exceedingly interesting, if true. It might give the explanation for something we so often find in clay brick. We find kiln marked brick that have not had a load on them to cause anything like sufficient compression or that apparently have been subjected to the maximum temperature of the kiln. This raises the question of carrying the brick past the critical temperature at great speed. It may be that by putting the heat to it just as fast as you can when you are passing the critical point for the clay in question, it will eliminate kiln marking of the brick. We know, for instance, in clay brick that the time factor is just as important as temperature.

MR. ROSS:—Are you sure your brick was dry and your kiln was dry in the kiln marked brick?

DR. HARVEY:—You will find kiln marked brick under every condition you can conceive.

COMPARATIVE TESTS OF ENGLISH AND DOMESTIC WHITINGS[1]

By A. E. Williams and B. J. Woods

ABSTRACT

A knowledge of the properties of American whiting as compared with those imported from England is of importance to producers of the American material as well as to manufacturers of products in which whiting may be used.

Twenty-two samples of domestic and foreign whiting have been submitted to examination and tested as follows: (1) visual examination, (2) microscopic examination, (3) determination of fineness of grain by three methods, (4) partial chemical analysis, (5) effect of the different whitings on the softening point of ceramic cone mixtures, and (6) effect on rate of vitrification of porcelain bodies.

The results indicate that although the English whitings contain considerably more fine material of a colloidal nature, the American whitings appear to be sufficiently fine grained for all ceramic purposes.

This extreme fineness may play a part in assisting in the flotation of the frit in glazes containing a low percentage of clay, but apparently has no effect in the fluxing point of ceramic glaze or body mixtures.

Sufficient data has been obtained to permit of the preparation of tentative specifications for whiting for ceramic purposes and the main requirements of such a material are given.

Introduction

Interest in the production of whiting in the United States together with the fact that there is considerable prejudice among the potters in favor of using English whiting, makes an investigation of the various properties of these two classes of whitings desirable. The problem of preparing specifications for potters' whiting has also been considered by the "Interdepartmental Conference on Chemical Lime," which conference has prepared specifications for lime for various other industrial uses. Specifications could not be prepared without a study of the comparative properties of the foreign and domestic products, as much is claimed for the physical condition of the material found in the English chalk deposits.

Information regarding the requirements of the potter is very necessary to the producer of this material or any other. There has been more or less justified complaint of domestic pottery materials by the potters of the United States. The producer did not know or realize the care which should be given the preparation of potters' material in order that the product might be consistent in quality from month to month and year to year. This lack of knowledge on the part of the producer has caused him to ship domestic materials to the potter which were not properly and uniformly prepared and therefore have caused considerable trouble and developed prejudice that is very hard to overcome.

Quality of American Limestones.—American limestones occur in several districts as a very pure calcium carbonate rock, so that so far as

[1] Published by permission of the Director of the Bureau of Standards, Department of Commerce.

purity is concerned domestic whitings equal to those available anywhere can be produced. It is only necessary to put this rock in the physical condition considered satisfactory to the potter.

Samples of Whiting Examined.—In order to proceed with this work samples of whiting actually being used were gathered from potters and dealers with a request for as much information as possible regarding their origin. Twenty-two samples have thus been selected for test, representing foreign and domestic products. These are listed with their sources in Table I.

TABLE I

SHOWING KIND AND SOURCE OF WHITING

No.	
1	Lump or ordinary whiting—Meeching Chalk Quarries, Newhaven, Sussex, England.
2	Finest ground Paris white—Meeching Chalk Quarries, Newhaven, Sussex, England.
3	Whiting—prepared in U. S. from crude chalk imported from England.
4	Paris white—prepared in U. S. from Cliffstone Rock imported from England.
5	Paris white—obtained from dealer in U. S.; imported as Cliffstone Paris white.
6	Whiting—obtained from potter in U. S.; made from imported English chalk.
7	Paris white—obtained from potter in U. S. who specifies English Cliffstone Paris whiting.
8	Paris white—obtained from potter in U. S.; bought as Paris white.
9	Paris white—obtained from potter in U. S. who specifies imported Paris white.
10	Paris white—obtained from dealer in U. S.; made from English Cliffstone Rock.
11	Domestic whiting—obtained from dealer in U. S.
12	Domestic whiting—obtained from dealer in U. S.; ground domestic limestone.
13	Domestic whiting—obtained from tile manufacturer.
14	Domestic whiting—obtained from potter.
15	Domestic whiting—obtained from dealer of ground limestone.
16	Domestic whiting—obtained from sanitary ware manufacturer.
17	Domestic whiting—obtained from tile manufacturer.
18	Domestic whiting—obtained from pottery manufacturer.
19	Domestic whiting—obtained from dealer in U. S.; coarse grade ground limestone.
20	Domestic whiting—obtained from producer in U. S.; ground calcite rock.
21	Domestic Paris white—obtained from dealer in U. S. Raw material not known.
22	Domestic whiting—obtained from dealer in U. S.; chemically precipitated whiting.

The examinations and tests made on these whitings were as follows: (1) visual examination; (2) microscopic examination; (3) determination of fineness of grain by the following methods: (*a*) rate of settling in water, (*b*) air separation by use of the Pearson air separator, (*c*) screening; (4) partial chemical composition; (5) effect of whitings on softening point of ceramic cone mixtures; and (6) effect on rate of vitrification of porcelain bodies.

Visual Examination.—Comparing the appearance of English and American whitings, considerable difference in color is observed in some instances, the domestic product being very much whiter than the English. The English whiting has a dirty gray-white color in comparison with a good white powder of any kind, and also shows a tendency to segregate into

little pellets rather than to flow as a fine powder. Some domestic whitings also show this same tendency, and exhibit shades of white that are intermediate between the English product and the whitest domestic material. The color of these powders is greatly affected by fineness of grain and this factor may be the principal cause of such color differences. In the gray samples showing a tendency to be lumpy no black specks were visible; the white samples, however, all showed visible black specks. These were identified in one case as particles of coke, being very soft and friable. The gray color may serve to mask the visibility of these specks.

Microscopic Examination.—Microscopic examination of these samples brings out several distinguishing features between imported and domestic whitings. The imported whitings are known to come from a soft marine formation, and to consist of rather fragile shell material. Under the microscope these whitings show as a mass of small fragmentary particles with occasional circular or semi-circular particles distinguishable as shells. Domestic whitings appear as sharper-edged particles without the occasional shells.

The imported whitings show a considerable amount of Brownian movement in the ultra-microscope, whereas domestic whitings do not show this phenomenon. There is, therefore, a difference in fineness shown by the smallest particles of the two classes. No visible difference was found between the washed product made from cliffstone rock and that made from chalk. The unwashed rock or chalk does not show any Brownian movement when simply broken up in a mortar and examined. Chemically precipitated whitings seem to be rather fine grained but quite uniform in size and show none of the large fragments found in the ground rock whitings.

Report of Microscopic Examination

Microscopic examinations were made by W. H. Fay, of the Bureau of Soils in the Department of Agriculture, who examined them especially for colloidal material; his detailed report is given herewith:

The twelve samples of whiting submitted for microscopic and ultra-microscopic examination gave the following results: Nos. 12, 16, 21, 20 and 11 all show distinctly crystalline materials with little tendency to aggregate. The size of the particles varies in each sample over an extremely wide range. All the other samples, Nos. 15, 2, 22, 3 and 4, show very small grained particles all of a fairly uniform size. Nos. 12, 15, 16, 21, 22, 20 and 11 show practically no colloidal material under the ultra-microscope. Nos. 2, 3, and 4 all show some materials of colloidal dimensions though in no case does this small material constitute any very considerable percentage of the whole sample.

In addition to the foregoing résumé we are sending you the detailed report of the examination of each sample as follows:

No. 12. Under petrographic microscope—grain-size very varied, but practically all of the visible particles are discrete crystals showing no marked tendency to aggregate. Distinctly crystalline. Very small amount of quartz, etc. Under ultra-microscope, practically no colloidal material visible.

No. 15. Under petrographic microscope—grains distinctly crystalline between crossed nicols. Grain-size very small and uniform, with a very strong tendency to aggregate. Under ultra-microscope, practically no colloidal material visible.

No. 16. Under petrographic microscope—distinctly crystalline. Grain-size very varied but not quite so extreme as under No. 12. No marked tendency to aggregate. Under ultra-microscope, practically no colloidal material visible.

No. 21. Under petrographic microscope—distinctly crystalline. Grain-size varied but apparently less so than with No. 16. Some tendency towards aggregates. Smaller particles seem more abundant proportionally than in No. 12 and No. 16. Under ultra-microscope, practically no colloidal material visible.

No. 2. Under petrographic microscope—distinctly crystalline. Grain-size very small and uniform with a strong tendency to aggregate, though this tendency is apparently less than in No. 15, neither are the grains quite so small as a rule.

Under ultra-microscope, material fine in size showing considerable Brownian movement, although the actual percentage amount of particles of colloidal size does not appear very great.

No. 22. Under petrographic microscope—distinctly crystalline. Grain-size very small and uniform, with a very strong tendency to aggregate. Under ultra-microscope, material of very fine size, showing practically no Brownian movement.

No. 3. Under petrographic microscope—distinctly crystalline. Grain-size very small and uniform, with a very strong tendency to aggregate. Under ultra-microscope, about as under No. 2.

No. 4. Under petrographic microscope—distinctly crystalline. Grain-size small, but still somewhat larger than in No. 3, and usually uniform, although there are very marked sporadic exceptions. There is a tendency to aggregate but it is very much less than in No. 3. Under ultra-microscope, some Brownian movement, but apparently less than in Nos. 2 and 3.

No. 20. Ground Calcite—under petrographic microscope—distinctly crystalline. Grain-size very unequal, with the mass of smaller particles distinctly larger than in No. 3, for example. Practically no tendency to aggregate. Under ultra-microscope, practically no colloidal material visible.

No. 11. Domestic Paris White—under petrographic microscope—in all respects, about as under No. 20. Under ultra-microscope, practically no colloidal material visible.

Crude English Chalk—material lumpy, therefore necessitating grinding in agate mortar before microscopic examination. Under petrographic microscope about as under No. 3. Under ultra-microscope, ground material shows practically no Brownian movement.

Crude English Cliffstone, Paris White—material lumpy, therefore necessitating grinding in agate mortar before microscopic examination. Under petrographic microscope, about as under No. 4. Under ultra-microscope, ground material shows practically no Brownian movement.

Relative Fineness of Grain

The physical structure, especially the fineness of the material, is considered by many to be the chief distinguishing feature in favor of the use of English whiting. There is no doubt that there is a great difference between a product in which the grains are made up of fragile material and a product produced by grinding hard rock. The material composing the

chalk cliffs of England is fragile shells or fragments of shells, very easily crushed to a powder and the resulting particles have feather-like edges, rather than sharp, angular edges.

The No. 140 and No. 200 screen sizes, U. S. Standard, were determined by wet screening, using a 10-gram sample on a 3-inch screen and a small stream of water practically without pressure. Washing was continued for ten minutes.

Various methods were tried to determine the grading in size of the particles finer than those passing 200-mesh screen, such as determining the rate of settling by use of the Odén balance, or by determining the change in turbidity with time. However, these did not give what were considered valuable results because the agglomeration of the particles caused settling more rapidly than the true fineness would indicate. Attempts to deflocculate were not successful, thus a true separation of the material into its ultimate particles was not possible. A method[1] of air separation that is being developed by the Cement Section of this Bureau gave probably the most accurate separation of particles finer than 0.05 mm. Grades designated as Nos. 01, 1, 2 and 3, approximating what might be called 2000-, 1000-, 500-, and 350-mesh sizes were so separated. The maximum size of particles for each of these grades is given, being an average of the width of fifty particles collected on a microscopic slide in the dust collector.

Comparing the fineness of whitings (Table II) from these results, there is no practical difference evident for sizes equivalent to 200-, 350-, and 500-mesh sizes. Only two samples, Nos. 16 and 19, show less than 85% of the material finer than the equivalent of 500-mesh (No. 2 size on air analyzer) and one of these, No. 19, is a coarse-grained product, not marketed as a whiting but simply as ground limestone. These same samples and one other (No. 12) are the only samples leaving a residue of more than 2% on a No. 200 screen. Important differences in fineness are only evident in the finest separation made (size 0.01 on the air analyzer passing about a 2000-mesh screen). The whitings made from English chalk or cliffstone show 68% or more material finer than this size, while no domestic product has more than 65%, and the average of 11 samples, not including No. 19, is only 46.9%.

Another simple method of separation was tried which consisted in shaking $2\frac{1}{2}$ grams of whiting in water in a 250-cc. graduated cylinder filled to the 250-cc. mark, and noting the time when visible motion of the particles ceased entirely, and when the turbidity had been reduced sufficiently to make a red line at the 150-cc. mark visible through the liquid. In clear skylight without sun satisfactory check readings were obtained. The results (Table II) show a definite distinction between the product made

[1] J. C. Pearson and W. H. Sligh, "An Air Analyzer for Determining Fineness of Cement," U. S. Bur. Standards, *Tech. Paper* **48.**

TABLE II

TABLE SHOWING SIZE OF GRAIN IN ENGLISH AND DOMESTIC WHITINGS

	Mechanical analyses Pearson air separator: Air analyzer Per cent blown off				Microscope's measurements				Screen analysis			Rate of settling of whiting in distilled water	
	No. .01	No. 1	No. 2	No. 3	No. .01	No. 1	No. 2	No. 3	Per cent residue on No. 140	Per cent residue on No. 200	Per cent passing No. 200	Time of visibility of red line at 100 cc. from top	Time when visible motion of particles ceased
						English Whiting							
1	87.4	97.7							0.0	0.2	99.8	25 minutes	27 minutes
2	87.5	97.8							0.1	0.1	99.8	Not visible in 30 minutes	30 minutes
3									0.2	0.4	99.4		
4									0.3	1.4	99.8		
5	74.6	86.7	95.4		0.0128	0.0213	0.0400		0.2	1.1	98.7	Not visible in 30 minutes	24 minutes
6	82.7	92.2			0.0132	0.0251			0.0	0.5	99.5	Not visible in 30 minutes	24 minutes
7	68.8	81.2	91.6		0.0135	0.0257	0.0420		0.5	1.4	98.1	Not visible in 30 minutes	24 minutes
8	75.0	84.3	93.2		0.0117	0.0225	0.0403		0.3	1.0	98.7	23 minutes	30 minutes
9									0.0	0.1	99.9	23 minutes	27 minutes
10									0.0	0.0	100.0	25 minutes	20 minutes
						Domestic Whiting							
11	48.0	70.4	99.7		0.0125	0.0217			0.0	0.0	100.0	5 minutes	11 minutes
12	52.6	69.9	85.5		0.0112	0.0242	0.0418		1.8	2.2	96.0	25 minutes	30 minutes
13	49.6	73.3	95.4		0.0115	0.0208	0.0435		0.1	0.3	99.6	16 minutes	20 minutes
14	56.8	70.2	88.6	95.8	0.0120	0.0218	0.0362	0.0501	0.0	0.1	99.9	12 minutes	25 minutes
15	47.6	96.7			0.0152	0.0220			0.2	0.2	99.6	10 minutes	15 minutes
16	28.4	41.9	70.4	83.2	0.0115	0.0210	0.0384	0.0610	5.5	2.8	91.7	10 minutes	15 minutes
17	36.0	63.4	96.8		0.0118	0.0207	0.0407		0.0	0.0	100.0	5 minutes	15 minutes
18	36.2	96.6			0.0130	0.0240			1.5	0.5	98.5	4 minutes	13 minutes
19	5.7	13.0	35.4	45.6	0.0124	0.0221	0.0389	0.0549	45.2	11.3	43.5		
20	53.8	74.4	96.0		0.0125	0.0211	0.0414		0.0	0.0	100.0	7 minutes	18 minutes

from English chalk and American ground materials, such that at present this may be used as a means of identification of the English product. The time when visible motion ceases is 24 minutes or longer for the English whiting, whereas but two of the domestic samples required so much time. The time required for settling sufficiently to form a clear liquid at the top was 23 minutes or more for the English whitings, whereas but one domestic sample required more than 16 minutes.

Evidence that English whitings contain a considerable percentage of material much finer than domestic ground products has thus been shown microscopically, by mechanical air separation, and by settling in water. The percentages of coarser particles such as 140-, 200-, and 350-screen sizes are practically the same and consequently there is no difference in the possibilities of trouble resulting from occasional coarse particles. Whether the amount of extremely fine material makes any practical difference, except where flotation of a slip is desired, is doubtful; at least no evidence of such differences was shown in any of the tests made in this work.

Chemical Composition.—Comparison of domestic and English whitings on a basis of chemical composition shows but little difference in their qualities, so far as iron content and insoluble residue are concerned. Considering the results shown in Table III the iron content is generally

TABLE III

RESULTS OF ANALYSIS OF ENGLISH AND DOMESTIC WHITING

No.	Per cent Fe_2O_3	Per cent insol. residue after boiling in HCL	No.	Per cent Fe_2O_3	Per cent insol. residue after boiling in HCL
1	0.084	1.61	12	0.243	3.51
2	.111	1.74	13	.243	2.65
3	.110	3.25	14	.150	1.61
4	.130	2.18	15	.248	1.16
5	.062	1.69	16	.315	7.82
6	.101	2.25	17	.152	1.64
7	.089	1.63	18	.158	1.85
8	.098	2.30	19	.231	5.49
9	.124	1.34	20	.167	1.32
10	.124	1.34	21	.172	3.23
11	.077	1.47	22	.201	1.27

higher for domestic samples but in most cases so low as to be of no consequence. The insoluble residue is about the same for English and domestic whiting except for two samples, Nos. 16 and 19, the latter being a coarsely ground limestone rather than a whiting.

Qualitative analysis for sulphur rarely gives any positive results unless the solution is allowed to stand over 12 hours, and then the quantity is only evident as a slight turbidity. It would appear that sulphur present in any form in so small an amount that a precipitate will not appear within

a few minutes after barium chloride is added to the hot solution may be regarded as negligible.

It is generally recognized that whiting is a practically pure calcium carbonate. The English product contains no magnesium, but domestic limestones may contain one to two per cent. Small percentages of magnesium cannot be considered as harmful to a whiting for pottery purposes.

Specific Gravity of Whiting.—Density determinations were made on a variety of samples illustrating the general types of raw material used. These are shown in the following table (IV) and indicate that except for the precipitated product the densities are nearly identical.

TABLE IV

SHOWING SPECIFIC GRAVITY OF WHITING SAMPLES

Sample number	Source of material	Specific gravity
3	English Chalk	2.721
4	English Cliffstone Rock	2.721
12	Ground Limestone	2.733
13	Ground Limestone	2.727
20	Ground Calcite Rock	2.729
22	Chemically Precipitated	2.587

Putty-making Properties.—A property peculiar to English whiting, which property products ground from American raw materials or the chemically precipitated sample do not show to such an extent, is the ability to mix with linseed oil to make a satisfactory putty. English whitings when mixed with 14% to 15% of oil produce a fairly plastic putty having a fair amount of cohesion. American samples require from 14 to 34.5% of oil and their value as a putty decreases with the amount of oil required, both because they do not have proper cohesion and because they require too much oil. Whitings requiring more than 18 per cent of oil to produce proper working plasticity do not make good putties. Table V shows a comparison of the oil absorption and putty-making properties of whitings tested.

TABLE V

TABLE SHOWING PERCENTAGE OF STANDARD LINSEED OIL REQUIRED TO BRING WHITING TO PROPER CONSISTENCY TO WORK AS PUTTY AND THE PERCENTAGE REQUIRED TO DILUTE IT BEYOND A WORKING CONSISTENCY. ALSO THE RELATIVE WORKING QUALITIES

No.	Per cent oil for proper consistency	Per cent oil making putty too fluid	Quality of putty
1	15.0	15.5	Good
2	15.1	15.6	Good
3	....	....	....
4	....	....	....
5	15.1	15.9	Good
6	15.2	16.0	Good

7	14.3	15.1	Good
8	13.9	14.3	Good
9	15.5	16.1	Good
10	15.0	15.7	Good
11	14.7	16.3	Short
12	13.3	13.9	Good
13	18.0	18.8	Fair
14	15.0	15.6	Good
15	28.7	30.4	Short
16	14.9	16.2	Short
17	22.3	23.4	Short
18	30.0	32.9	Short
19	....	....	....
20	....	....	....
21	17.0	17.6	Good
22	33.0	34.0	Very short

If this property were one due to extreme fineness of grain alone it might serve us as a distinguishing feature between English and domestic whitings. It has been suggested however that variety of sizes of grain might be the controlling factor causing adhesion and low oil absorption rather than fine material and that mixing material ground in two or more different ways might produce a satisfactory putty whiting.

Use of Whitings in Pottery Bodies and Glazes.—Experience has shown that whitings containing relatively coarse grains produce unsatisfactory results. The maximum grain size which may be included without detriment has not been determined. While it seems obvious that extreme fineness is desirable in whitings for both bodies and glazes, it also seems probable that there is a limit in fineness beyond which further reduction in the size of particles would have no appreciable effect. Since it was impossible to conclude, from the information available, whether the whitings produced from English stone and containing a considerable proportion of material which is finer than the finest portion of the domestic whitings would give better practical results than the domestic material, a series of trials was made to determine the relative behavior of the two types.

In order to detect, if possible, any difference in the behavior of these whitings as far as body mixtures are concerned, cones approximating cone 4 in composition were made in which the brand of whiting was the only variable. The composition of the cones were: Maine feldspar, 42.1%; flint 27.2%; whiting 17.6% and North Carolina kaolin 13.1%. The mixture was ground dry in a ball mill except for the whiting content, which was later mixed with the proper proportion of the ground body and mixed thoroughly in a mortar.

Two burns were made, the cones on four plaques being placed in the center of a muffle with standard cones in the center of each plaque. In one burn the temperature was increased rapidly as the melting point of the

cones was approached, the rate being 100° per hour from 1100° to 1200°C. In the other burn the temperature was increased not more than 20° per hour from 1000° to the finish, although the 20° increases were occasionally not uniform, the rise in temperature being obtained during the first 15 minutes of the hour. The uniformity of temperature in the muffle is best judged by the fact that standard cones of the same number in different locations in the furnace went down practically together on the rapid burn, and within an interval of 20 minutes, during which there was a temperature increase of 15° in the long burn. In both burns sample No. 19, containing a very coarse ground limestone as shown by the screen tests, did not fuse readily but remained standing at a temperature of 20° higher one hour after all

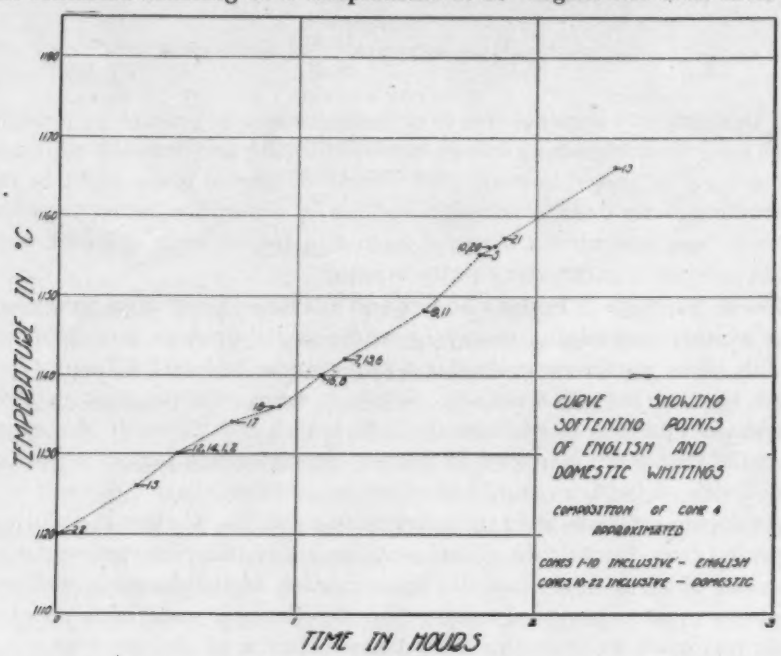


FIG. 1.

others had fused. In the rapid burn all cones softened within a temperature interval of 10° beginning at 1145°C except the standard cones which started to deform just previous to the test cones. In the slow burn the standard cones went down between 1100° and 1115°C over a period of 15 minutes. The test cones deformed beginning at 1120° and extending over a temperature range of 35° and a period of 1 hour and 45 minutes. Fig. 1 is a time-temperature curve on which is indicated the fusing points of the various cones. It will be noted that there is no consistent difference between English and American whitings, there being as great a variation in the English product as in the American whitings.

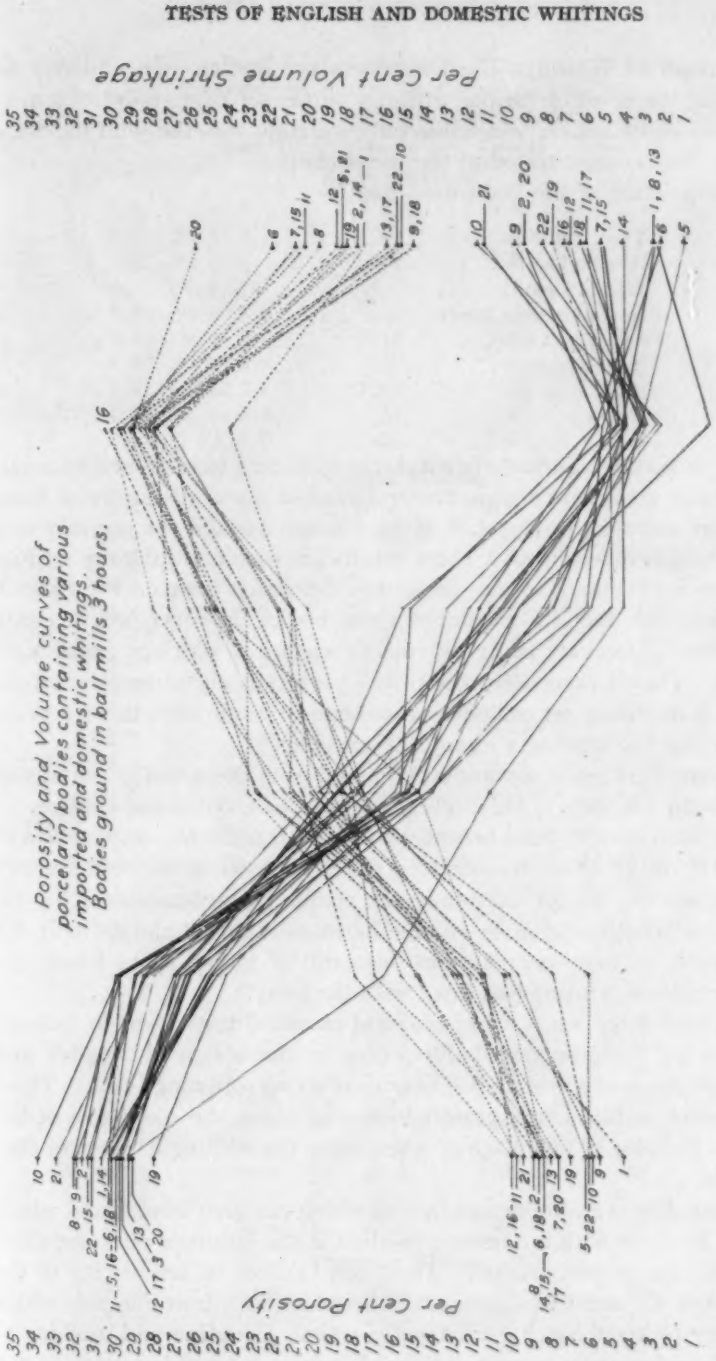

Porosity and Volume curves of porcelain bodies containing various imported and domestic whitings.
Bodies ground in ball mills 3 hours.
Per Cent Porosity
Per Cent Volume Shrinkage
Temperature in Cones
4
6
8
10
12
14

FIG. 2.

Comparison of Whitings Used in Porcelain Bodies.—In addition to determining the effect of various whitings on the softening point of a mixture, porcelain bodies, in which the only variable was the whiting, were also made, burned and tested in the usual manner.

The composition of the body used was:

Tenn. ball clay No. 5	5.7%
Georgia kaolin	9.5%
Florida kaolin	9.5%
North Carolina kaolin	9.5%
Delaware kaolin	9.5%
Potash feldspar	17.7%
Flint	36.6%
Whiting	2.0%

One set of bodies was made in which the materials were ground in a ball mill for three hours and screened over 120-mesh lawn. Samples of these bodies were burned to cones 4, 6, 8, 10, 12, and 14, and the porosity and volume changes determined. These results are shown graphically on Fig. 2 and offer no evidence of any consistent difference between the English and domestic product. Grinding of these bodies, however, might easily have served to eliminate many differences which the whitings might have produced. This is especially true of the very coarsely ground limestone No. 19. A duplicate set of bodies was therefore made with the exception of introducing the whiting without any grinding.

Two burns were made of samples prepared from these bodies containing the unground whitings. Although the porosities and volume changes do not check from burn to burn because of furnace conditions, examination of Tables VIII and IX shows no consistent difference evident between the two classes of whiting except that the very coarse grained sample (No. 19) did not give a large change in volume between cones 12 and 14 as it did when ground. These samples were also full of glassy spots where the coarse particles of whiting had fused with the body.

The results of the various physical and chemical tests seem to indicate that there are no pronounced differences in the action of English and domestic whitings in porcelain bodies or in affecting softening point. There is a difference in fineness of grain which may affect the usefulness of the whiting in the case of raw glaze or when using the whiting in place of clay to float the glaze.

There are, however, important factors which can give trouble and which are likely to occur with a domestic product if the producer does not exert the proper care in preparation. These are (1) lack of uniformity of the product from shipment to shipment; (2) freedom from iron minerals which is necessary to avoid black specks in the ware. Grinding and washing of whiting should remove the possibility of trouble from this source as the

TABLE VIII

POROSITY OF BODIES AT CONES 12 AND 14

No.	Ground bodies Cone 12	Ground bodies Cone 14	1st burn Unground bodies Cone 12	1st burn Unground bodies Cone 14	2nd burn Unground bodies Cone 12	2nd burn Unground bodies Cone 14
			English Whiting			
1	0.0	2.7	0.15	0.40	0.17	0.28
2	5.6	9.2	.10	.60	.61	9.04
3	...	....	.10	.50	.33	9.25
4	...	....	....	.50	2.25	11.42
5	3.5	1.2	.15	.30	5.33	13.88
6	4.4	2.4	2.50	4.40	0.65	8.8
7	4.6	5.6	.15	.10	.15	8.8
8	5.7	2.8	1.40	.25	.19	10.8
9	4.3	9.8	.25	.20	.22	8.4
10	2.5	11.7	.04	1.00	.17	8.60
			Domestic Whiting			
11	3.4	6.3	0.70	0.0	0.18	6.2
12	4.7	7.0	.30	.1	.42	5.5
13	4.2	2.9	1.6	2.6	.45	4.5
14	4.3	4.5	2.9	....	.31	7.6
15	4.2	5.5	0.0	2.8	.62	9.9
16	3.5	7.4	2.0	1.0	.42	7.4
17	5.1	6.3	0.15	2.0	.24	8.6
18	3.2	6.6	.10	2.9	.16	6.4
19	5.1	9.0	5.40	2.5	1.3	1.7
20	2.7	9.5	.26	....	.11	9.9
21	4.4	11.4	.40	0.10	.35	.42
22	3.3	8.5	.35	6.0	.10	12.1

TABLE IX

VOLUME SHRINKAGES AT CONES 12 AND 14 COMPARING GROUND AND UNGROUND BODIES

No.	Ground bodies Cone 12 1250°C	Ground bodies Cone 14 1400°C	Unground bodies 1st burn Cone 12 1240°C	Unground bodies 1st burn Cone 14 1400°C	Unground bodies 2nd burn Cone 12 1315°C	Unground bodies 2nd burn Cone 14 1340°C
			English Whiting			
1	29.4	17.0	32.8	28.5	31.2	26.8
2	28.8	17.6	32.7	28.7	29.2	23.2
3	....	....	28.7	25.4	31.4	25.3
4	....	....	28.5	24.9	32.0	25.8
5	27.0	18.3	27.9	22.8	25.3	23.2
6	29.1	21.8	27.2	25.2	31.2	20.0
7	28.1	20.8	29.9	28.0	30.5	21.0
8	27.0	19.5	27.9	26.6	28.5	23.0
9	28.5	14.8	32.2	24.5	31.0	22.2
10	27.8	15.4	32.8	28.5	27.7	21.8
			Domestic Whiting			
11	28.9	20.2	27.5	28.4	31.2	25.7
12	28.2	18.6	29.2	29.4	26.3	24.1
13	27.6	16.2	30.3	26.6	28.5	25.3
14	28.1	17.5	23.5	25.4	29.2	23.5

TABLE IX (*Continued*)

No.	Ground bodies		Unground bodies			
			1st burn		2nd burn	
	Cone 12 1250°C	Cone 14 1400°C	Cone 12 1240°C	Cone 14 1400°C	Cone 12 1315°C	Cone 14 1340°C
			English Whiting			
15	29.3	20.6	29.8	24.0	29.3	22.7
16	30.2	....	30.9	18.4	30.1	21.5
17	27.7	16.4	29.2	26.0	24.7	25.7
18	28.8	14.7	28.9	29.2	30.5	22.8
19	26.9	18.2	28.0	19.6	29.3	28.8
20	28.8	25.7	30.1	20.5	29.5	24.2
21	29.9	17.0	31.4	25.4	24.5	26.2
22	29.5	15.6	32.0	29.5	22.8	25.7

heavy particles can be settled out with the coarse material. (3) The last factor is freedom from particles of gypsum ($CaSO_4 2H_2O$) because of the sulphur it introduces. Sulphur is given as the chief cause of scumming found after the glost burn, and occasional cases of scumming have been attributed to the whiting. Thus minerals containing sulphur are prohibitive, and can be eliminated by selecting the stone for grinding. Domestic whiting suitable for ceramic uses can be produced and the success or failure of a domestic product depends almost entirely on the care of the producer.

As a result of the various comparative tests made, a tentative specification for whiting has been prepared by the "Interdepartmental Conference on Chemical Lime."

The important qualifications specified are repeated with the following requirements:

(1) *Quality.*—Whiting shall be uniform in quality (from shipment to shipment), both as to fineness of grain and composition, each shipment meeting the requirements given below. It shall be manufactured from the purest limestones available, and shall be free from pyrites, iron-bearing silicates, metallic iron, and gypsum.

(2) *Composition.*—Whiting shall have the following limitations in composition:

Material	Total carbonates	$CaCO_3$	$MgCO_3$	Fe_2O_3
Maximum	....	....	2%	0.2%
Minimum	97%	95%	...	.....

A qualitative test shall indicate the absence of sulphur.

(3) *Fineness.*—Screening samples by washing for ten minutes with a stream of water of low pressure shall not leave a residue of more than 1% on a No. 140 screen (or more than 2% on a No. 200 screen), and at least 98% of the material shall pass a No. 200 screen. Whiting shall also be so

fine that a separation made by a Pearson[1] air separator will show at least 85% of the material finer than 0.02 mm. and at least 48% finer than 0.01 mm.

As an alternative to the Pearson air separator method the following method (not so desirable) may be used: $2^1/_2$ grams of the material shall be shaken for ten minutes in a 250-cc. cylindrical graduate with 250 cc. of distilled water. On allowing to settle it shall require not less than 20 minutes for visible settling to cease when the cylinder is viewed in reflected light, using clear north skylight for illumination.

U. S. BUREAU OF STANDARDS
WASHINGTON, D. C.

[1] J. C. Pearson and W. H. Sligh, *loc. cit.*

THE MEASUREMENT OF THE PLASTICITY OF CLAY SLIPS[1,2]

By Robert E. Wilson and F. P. Hall

ABSTRACT

1. The paper emphasizes the great need of a quantitative measure of the physical properties commonly included in the term "plasticity" of clays and clay slips. Various indirect methods previously suggested are likely to lead to erroneous conclusions, while measurement of the flow or apparent viscosity of clay slips made up with a constant amount of water is shown to give misleading results.

2. The work described in this paper is preliminary in nature and has been confined to a study of the properties of clay-water mixtures in the casting rather than in the molding range. In the light of these results it is recommended that, instead of the vague term plasticity, the properties of a given clay, at least for casting purposes, be expressed in terms of (*a*) the water content required to give proper working consistency, and (*b*) the resistance of the resulting slip to small deforming forces (such as gravity). Specifically, use is made of a modified Bingham plastometer, and the figures reported are (*a*) the amount of water required to give a slip of a specified mobility, and (*b*) the yield value of the slip thus obtained.

3. The method is shown to be capable of giving quantitative figures for the yield values at constant mobility which correspond well with the customary qualitative ideas as to the plasticity of clays. The amount of water required to give constant mobility varies to a surprising extent, and does not appear to bear any definite relationship to the usual classifications of more or less plastic clays. It probably does parallel fairly well the shrinkage on drying.

4. Small amounts of acid or alkali are shown to have a negligible effect on the mobility of a clay slip, but a very large effect on the yield value, the variations being greater than the difference between a non-plastic kaolin and a highly plastic ball clay. This brings out the necessity, and indeed the potential value, of carefully controlling the hydrogen-ion content of the water used in making the slips.

5. Some preliminary data are given on the effect of additions of flint and similar non-plastic materials to clay slips.

6. It is recommended that an attempt be made to agree upon standard dimensions for the capillary and the desirable mobility for various purposes, and that the plastometer then be used as a standard method of test in the ceramic industry.

Introduction

From a practical standpoint, "plasticity" is one of the most important properties or rather combination of properties possessed by any clay. Different clays are known to vary greatly in plasticity. Furthermore, in practical clay working, substances are frequently added for the express purpose of increasing or decreasing the plasticity of the final mix.

In spite of these facts, however, no unit of plasticity has ever been defined, and there is no generally accepted method of measuring or comparing

[1] Published as *Contribution*, No. 63 from the Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology. Simultaneous publication by courtesy of Dr. H. E. Howe, Editor of *The Journal of Industrial and Engineering Chemistry*.

[2] Presented before the division of Physical and Inorganic Chemistry at the New York meeting of the American Chemical Society, Sept. 1921.

the plasticity of different clays. To be sure, many indirect methods have been suggested for its quantitative measurement. For example, the amount of adsorption of malachite green, the adsorption of alkali from various salt solutions, the strength of clay bodies after drying, the amount of water required to bring the clay to proper consistency, etc. These factors are undoubtedly in some way related to plasticity, being common results of similar causes, the main factors probably being the fineness of subdivision of the ultimate particles and their affinity for water. It is nevertheless true that in many cases clays may possess high adsorptive power for dyes, etc. (*e. g.*, fuller's earth) and yet have low plasticity. Such indirect methods of measuring plasticity have therefore not met with any general acceptance, and ultimate reliance is still placed on empirical tests by experienced clay workers, although even such individuals do not consistently agree with one another.[1]

It is obvious that the ultimate solution of the problem must involve the measurement of the physical properties of a clay slip with a water content approximately correct for practical use. Some efforts have been made in this direction by determining the flow of a clay slip through an orifice or by the use of paddle wheel viscometers, but these have not given satisfaction, partly because of the difficulty in determining just how much water should be added before making the test, and partly because it is not possible to measure the true viscosity of clay slips, as is evidenced by the subsequent discussion.

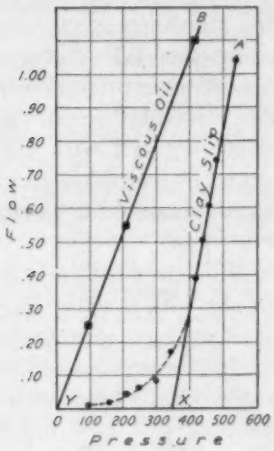
The most promising possibility for making the desired measurement appears to be the use of a device such as the plastometer, recently developed by Prof. E. C. Bingham.[2] Prof. Bingham has shown that when a plastic substance flows through a capillary of constant dimensions, the amount of flow is not directly proportional to the pressure used, as in the case of viscous liquids, but departs therefrom by giving abnormally low rates of flow for low pressures and then increasing more rapidly at higher pressures. The two different types of flow curve are illustrated very clearly in Fig. 1, which presents results for a very viscous oil and for a clay slip, in the capillary used in the work described hereinafter.

It is Prof. Bingham's belief that the rounding off in the curve in the lower portion may be due to slippage or seepage, and that the laws of plastic flow may for all practical purposes be represented by a straight line intersecting the abscissa axis at some point to the right of the origin. The distance to the point of intersection, in proper units, is defined as the yield point and the slope of the line is a measure of the mobility of the suspension. It is not the purpose of this paper to discuss the rather involved

[1] This has been strikingly confirmed by a paper by Bole which appeared after this paper had been written. See *Jour. Amer. Ceram. Soc.*, **5**, 469 (1922).

[2] U. S. Bur. Standards, *Sci. Paper* **278**.

points with regard to the cause and equation for the lower curved portion of this line, nor the questions which have arisen as to the degree of dependence of the results on the size of the capillary used. Both these factors, while of considerable theoretical interest, may for practical purposes be eliminated by agreement upon a standard capillary and by working with pressures which are sufficiently great, just as has been done in practical viscometry by using the Saybolt instrument.



Comparative Flow - Pressure Curves for a Clay Suspension and a very Viscous Oil Through the same Capillary

FIG. 1.

The reason for the difficulties and apparent contradictions encountered in measuring the "viscosity" of clay slips becomes apparent from the above. The calculation of viscosity from a single flow-pressure observation tacitly assumes that flow is directly proportional to pressure. Consider, for example, the two curves on Fig. 1: a measurement at very high pressure would indicate that the clay slip had a lower viscosity than the oil, while measurements at pressures of 100 or 200 gms./sq. cm. would indicate that the clay was more than ten times as viscous as the oil. By determining the complete curves and separating the apparent viscosity into its two components, mobility and yield point, the whole matter becomes clear. An attempt along somewhat similar lines has been made by Bleininger and Ross,[1] who measured the flow through an orifice of various clay mixes under variable pressure, but they drew no conclusions as to the significance of the results, or possible ways of measuring or expressing the two separate factors involved.

Apparatus and Manipulation

The apparatus used was a modified Bingham plastometer, shown diagrammatically in Fig. 2. It consists chiefly of a pressure stabilizer for maintaining constant pressure of several different magnitudes, a container for holding the material to be tested, into the lower end of which is fastened a capillary, and a manometer for measuring the pressure. A general description of the apparatus is given by Bingham in *Proceedings of the American Society for Testing Materials*, Vol. **XIX,** Part II, 1919. The flow meter as described by Bingham and Green was not used in these measurements, but the weight of the discharge and the density of the clay slip was used to determine the volume. The instrument is limited to materials which have a very slow "settling time." For very stiff pastes the

[1] Bleininger and Ross, *Trans. Amer. Ceram. Soc.*, **16,** 392 (1914).

pressure range must be great enough to permit the linear portion of the curve to be determined.

A number of preliminary trials were made to determine what size of capillary seemed most suitable for use on slips in the casting range. The smaller capillaries, such as used by Prof. Bingham, were not found satisfactory in working with clay slips, especially when coarser particles were admixed. When the most suitable capillary was finally selected its dimensions were carefully determined, the diameter by filling it level with mercury and weighing. It was found to have the following dimensions.

Length = 5.020 cm.
Diameter = 1.3624 mm.

The capillary was later measured with a high power micrometer microscope at the Bureau of Standards, which gave a figure of 5.021 cm.

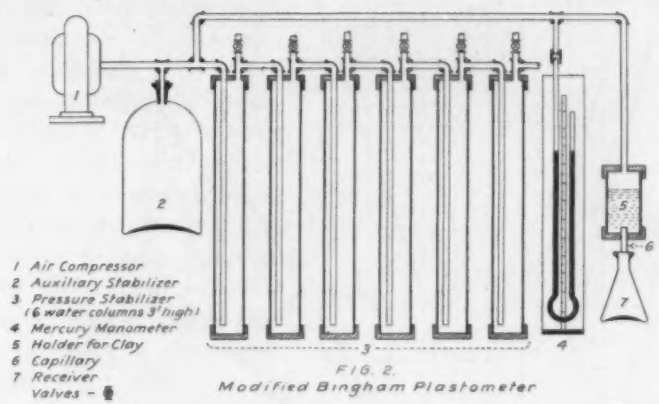


FIG. 2.
Modified Bingham Plastometer

for the length and 1.3636 mm. for the average diameter.[1] This capillary was used in all the tests discussed in the paper except where otherwise noted.

Source and Treatment of Clay Samples

The clays used in these experiments were selected to be representative of the clays that are used in the ceramic industry today.[2] The Georgia kaolin is a white-burning clay, free from grit, and with a soapy feel, due to the presence of many muscovite scales of microscopic size. The North Carolina clay is a kaolin of residual origin that is used extensively for the manufacture of whiteware. The Tennessee ball clay is a very plastic clay of sedimentary character and possesses very good bonding power.

[1] Calculated from major and minor axes of tube, cf. *Zeitschr. f. physik. chem.*, 80, 683 (1912).

[2] These were obtained from B. F. Drakenfeld Co., of New York City as representative samples of commercial clays.

The English ball clay is quite similar, in general, to the Tennessee ball clay. The English china clay is a very lean, white-burning kaolin. Several fire clays were tested, but their history was not known. All the clays used, except the ball clays, were subjected to a washing process before they were used. This is the same treatment that they receive before they are put on the market.

The clays were prepared for use by grinding until the entire mass passed the 65-mesh sieve. No attempt was made to separate the clay into different fractions. It is known that very fine grinding affects the plasticity, so it was thought best to use a large capillary in the plastometer and avoid grinding the clay so fine that its character would be changed.

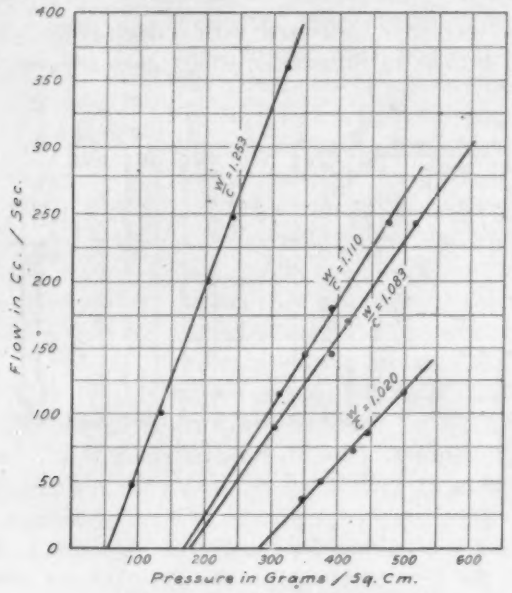


FIG. 3.
Effect of Water Content
on
Flow of Tennessee Ball Clay Slip

All the slips were made by adding weighed amounts of distilled water to a sample of the ground clay as received, but the ratio of water to clay was calculated to a bone dry basis by making determinations of total water content up to 900°C on separate small samples of each clay. The losses on ignition thus determined were as follows:

Clay	Per cent loss on ignition
English china clay.....	14.20
Georgia kaolin.....	11.80
Tennessee ball clay.....	10.25
English ball clay.....	13.00
North Carolina clay.....	12.00

Selection of Proper Method of Comparing Plasticities

Fig. 3 shows the results obtained with a Tennessee ball clay slip in which the proportion of water was varied. It is evident that as the amount of water is increased there is a continual tendency to increase the mobility and decrease the yield point of the suspension, and that any yield point or any mobility can be obtained with this or any other sample of clay. The property which is a fundamental characteristic of the clay itself, and which cannot be affected by changing the water content, is the functional relationship between these two.

While the term plasticity is often loosely used to include a variety of properties, such as lack of excessive shrinkage or cracking on drying, a "soapy" feeling in the slip, as well as a peculiar combination of working properties, there is no question but that the most important physical property desired in specifying the use of a "plastic" clay is that it shall maintain a reasonably high yield point after enough water has been added to bring its mobility to a value suitable for working. A clay which is much less plastic can be made to have the same yield point by using a very small amount of water, but it would then be too stiff to work; while if its water content were increased to secure the necessary mobility, the yield point would also drop off, resulting in inability to hold its shape after forming.

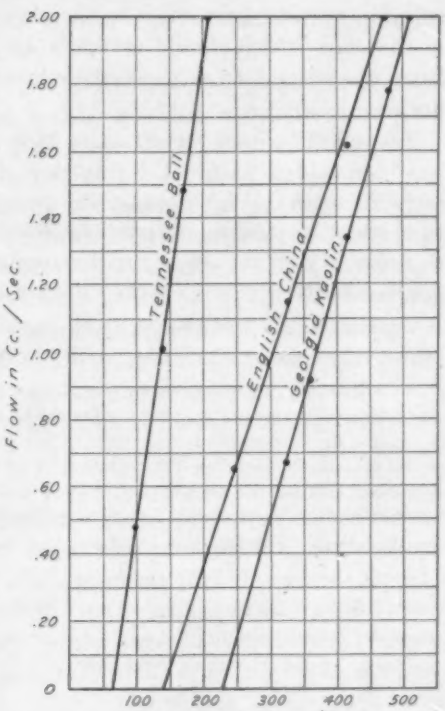


FIG. 4.
Flow of Various Clays with Constant Water Content $\frac{W}{C} = 1.253$

This brings to the fore the question of the proper basis for measuring and comparing the plasticity of two different clays. One suggestion which has been made is the addition of a definite amount of water to the clay followed by a determination of the flow curve. Fig. 4 shows the results obtained on three different clays with a constant ratio of water to

clay of 1.253.[1] It is impossible, however, from an inspection of such results, to decide which is the most plastic clay, because the question immediately arises—if less water had been added to the Tennessee ball clay, thus moving the line to the right, how would its slope compare with that of the other two?

It is therefore apparent that constant water content tests, though quite frequently employed in comparing clays, do not afford a suitable basis for comparison. Instead, the amount[2] of water required to give suitable working properties to the clay is in itself an important property of the clay, which should certainly be determined, but which is distinct from plasticity. It is probably related to the amount of shrinkage on drying.

The question next arises as to how to determine when enough water has been added to give the resulting slip suitable working properties for a given purpose. Several clays of quite different plasticities were made up to possess as nearly as possible similar working properties, and from this test (which should be further confirmed by investigators more closely familiar with ceramic practice) it appeared that clays of *constant mobility* possessed substantially identical working properties. The correct mobility value naturally varies with the purpose for which the clay slip is

[1] All the figures in the paper are plotted in terms of the actual flow (cc. per sec.) and pressure (grams per sq. cm.) used with the specified capillary. It would be desirable to express these in terms independent of the particular capillary employed, but in view of the previously mentioned uncertainty as to the precise validity of Bingham's simple equations, this has not been done. However, for purposes of comparing results between capillaries which do not vary widely in dimensions, use can well be made of the formula (see Bingham, "Fluidity and Plasticity," p. 323, McGraw-Hill, 1922):

$$\mu = \frac{1.273\,v}{R^3(F-f)}$$

where μ = the mobility
f = the friction or yield value
v = volume of flow in cc./sec.
F = shearing force applied at the wall of the capillary in dynes/sq. cm.
$= \frac{980.6\,RP}{2L}$, where
R = the radius of the capillary in cm.
P = the applied pressure in grams/sq. cm.
L = the length of the capillary in cm.

The *calculated* yield values for the capillary used in the foregoing work in terms of *shearing force* in *dynes per sq. cm.* may therefore be obtained by multiplying the graphically determined yield values given in this paper by

$$\frac{980.6 \times .06815}{2 \times 5.021} = 6.65$$

and the mobilities by substituting in the above equation.

[2] In the molding range this quantity is sometimes designated by the ceramists as the water of plasticity.

used, that selected for these tests being considered approximately correct for casting purposes before "freeing out" with alkali.

Clays should therefore be compared on the basis of (*a*) the amount of water required to give a specified mobility, and (*b*) the magnitude of the yield value when this amount of water has been added, this value presumably being higher the more "plastic" the clay. Testing clays by this method unfortunately necessitates working by trial and error and determining two points on the flow curve for each change in the amount of water added, but once the worker is fairly familiar he can approximate the proper mobility quite closely by estimation.

It is, of course, conceivable that by studying a large number of clays to which different amounts of water had been added, a definite functional relationship between mobility and yield value would be found to hold for a given type of clay, regardless of the water content, in which case only one measurement would have to be made. For example, it has been found as a rough approximation that for two samples of clay over a two-fold range of mobilities the yield value $\times$ mobility$^{1.7}$ = a constant, but tests on a third kind of clay did not appear to bear this out. While the foregoing method of defining and measuring the more important physical properties included under the vague term "plasticity" has thus far been applied only to the casting range, there appears to be no fundamental reason why it should not be extended to the molding range, although the high pressures required and the maintenance of steady flow, may present rather serious experimental difficulties.

It should be noted that this way of analyzing "plasticity" into its more important components crystallizes the whole problem and avoids such inconsistencies as the statement of some ceramists that clay passes through a narrow region of "maximum plasticity" in the molding range as the water content is increased. It is certainly highly improbable that any physical property really passes through a maximum with increasing water content, and the popular conception is again believed to be due to the attempt to combine too many properties in a single term. In other words, the region of "maximum plasticity" is in reality simply the region of the most desirable working properties (for molding) between the point where the clay is too stiff on account of insufficient water and too sticky or fluid from too much water.[1]

On account of the loose use of the term "plasticity" which can probably never be eradicated, the writers are inclined to recommend that instead of considering the yield value at constant mobility as a direct measure of "plasticity," that the term be dropped entirely when referring to the

[1] A very recent paper on the "Plasticity of Clays" by J. W. Mellor (*Communication from the Clay and Pottery Laboratory*, Stoke-on-Trent, No. 53) has thrown interesting light on this question from a somewhat different point of view.

physical properties of the slips. If water content and yield value at constant mobility should not be found to comprise all the important properties now included under "plasticity," an additional quantitative measurement and term could be added, but the separate properties of the clay should be accurately measured and uniquely defined rather than using a vague general term which means essentially "good working properties" for certain purposes. The situation is analogous to the change from saying that an oil possesses "good lubricating characteristics" to specifying precisely its flash point, cold test, viscosity at different temperatures, etc.

Comparison of Yield Values and Water Contents at Constant Mobility

For the reasons previously discussed, the water content of six samples of clay was adjusted to give the desired constant mobility suitable for casting and the yield values and water contents at these mobilities compared. The results are shown graphically in Fig. 5.

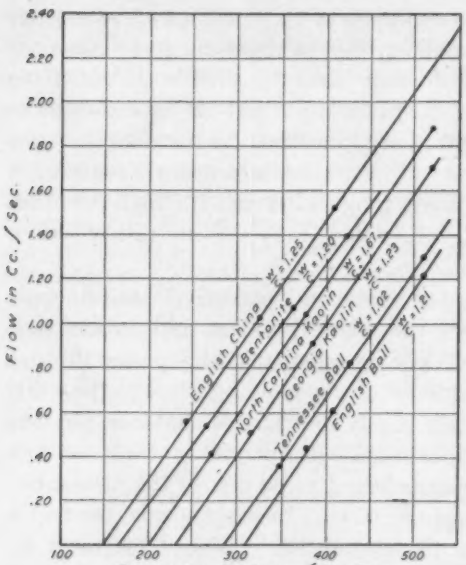


FIG. 5.
Comparison of Yield Value and Water Content at Constant Mobility

Neglecting for the moment the sample of bentonite, it will be noted that the order in which the clays arrange themselves with increasing yield value is as follows: English china clay, North Carolina kaolin, Georgia kaolin, Tennessee ball clay and English ball clay. This appears to correspond very well with the customary belief as to the relative plasticity of these clays and thereby confirms the essential validity of the test. It will be noted that the ratio of water to clay required to give these mobilities is quite variable, being as low as 1.02 for the Tennessee ball clay and as high as 1.67 for the North Carolina kaolin. Of the samples tested, the kaolins on the average required more water than the ball clays. The futility of comparing different clays at constant water content is obvious.

One very interesting sample is the bentonite, a very peculiar soapy clay of which there are large deposits in Wyoming.[1] Although the ben-

[1] Tests on the bentonite were made later by Mr. C. E. Ronneberg of this Laboratory with a capillary which differed slightly in dimensions, but the results were corrected to make them comparable.

tonite is customarily spoken of as being extremely plastic, it will be noted that on the selected basis of comparison its yield point is rather low, but that the ratio of water to clay required to give the desired mobility is many times as high as for any of the standard clays. It is probable that the common statements with regard to its plasticity are again based on a confusion of ideas resulting from the tendency to make plasticity cover too wide a range of properties. It is, of course, possible that when added in small amounts the remarkable properties of the bentonite might make a lean slip much more plastic, by coating the larger particles, or filling in the voids so as to give a closer packing effect such as that sought in concrete.

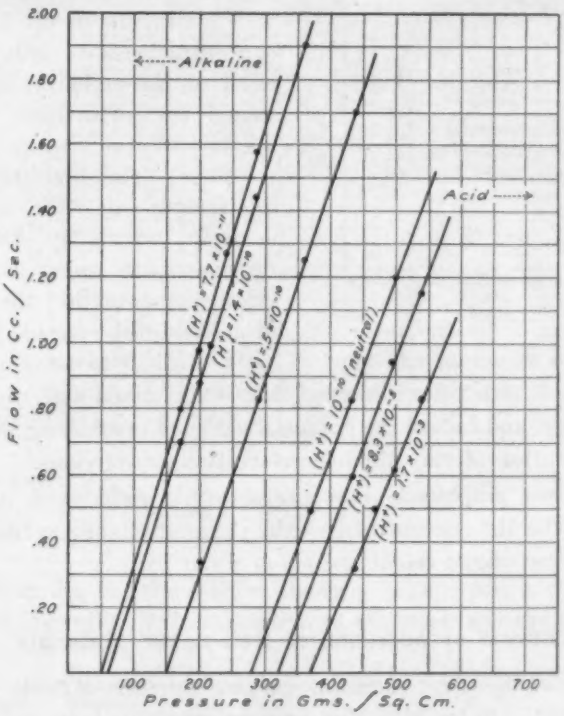


FIG. 6.
Effect of Varying Alkalinity and Acidity of Tennessee Ball Clay
$\frac{W}{C}$ *constant at 1.082*

Effect on Yield Value and Mobility of Variations in Acidity and Alkalinity

Having pointed out the two essential physical properties involved in plasticity, it is interesting to study the various methods which are used to modify the working properties of clays and determine just how they influence the fundamental variables of yield value and mobility.

For example, it has long been recognized that the acidity or the alkalinity of the water makes a marked difference in the working properties of the clays. Experiments were therefore carried out with Tennessee ball clay slips of constant water content but widely varying hydroxyl or hydrogen-ion concentration, obtained by adding NaOH or HCl to the water. The hydrogen-ion contents are calculated from the amounts added to the water, rather than being measured in the clay slips themselves.

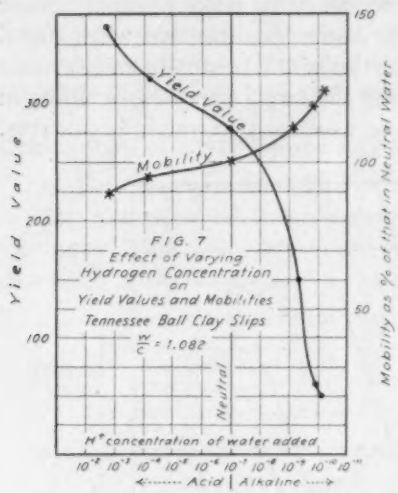


FIG. 7
Effect of Varying Hydrogen Concentration on Yield Values and Mobilities Tennessee Ball Clay Slips
$\frac{W}{C} = 1.082$

The results shown in Fig. 6 bring out the surprising fact that very wide variations in the hydrogen-ion concentration have only a negligible effect on the mobility, but gradually varied the yield value from 50 in alkaline solutions up to 370 in acid solutions. The function of alkalies in "freeing out" the clay, and of acids in "setting up" the clay, thus becomes quite apparent. It is also worthy of note that the yield value of at least this sample of clay can be varied by moderate additions of acids or alkali to cover a wider range than the whole series of commercial clays when mixed with distilled water. The necessity, and indeed the potential value, of controlling the hydrogen-ion concentration of clay slips therefore becomes obvious.

Fig. 7 shows graphically how the observed yield value and mobility varies with the H^+ concentration—the sharpest change in the yield value is obviously between a calculated *pH* of 8 and 10.

Effects of Additions of Non-plastic Materials

Fig. 8 shows the effect of adding varying amounts of finely ground sand ("Potters flint") to the clay slip, keeping constant, however, the ratio of water to total dry solids. The flint obviously does not hold nearly as much water as the clay and the effect of replacing clay with flint is therefore similar to that of adding water to the slip, increasing the mobility and decreasing the yield. It rather appears, however, that the effect on yield is less than that on the mobility in comparing the results with the addition of water alone. Additional tests should be made on mixtures of constant mobility and of constant ratio of water to clay, but variable amounts of flint.

The foregoing study is obviously preliminary in nature, but it is being continued by the junior author at the Bureau of Standards, a thoroughgoing investigation of the whole problem being under way.

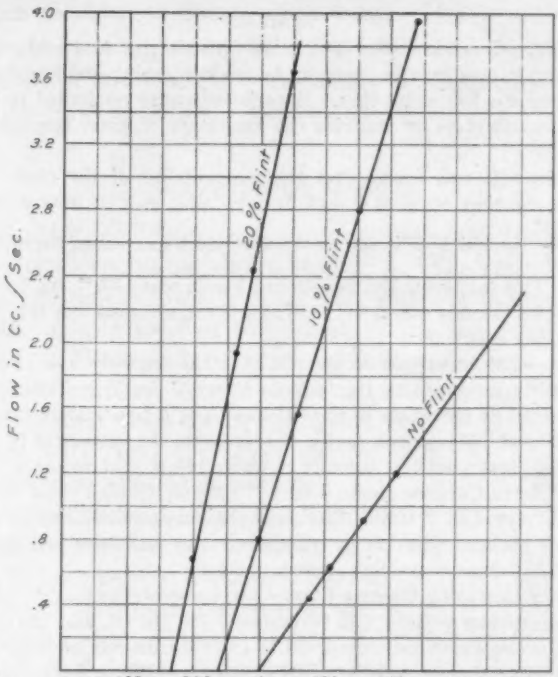


FIG. 8.

Effect of Finely Ground Flint on Flow of E.B. Clay Slip

$\frac{W}{C+F}$ constant at 1.21

The writers desire to acknowledge the helpful suggestions of Dr. Bingham in connection with the inauguration of the work and the preparation of the paper.

RESEARCH LABORATORY OF APPLIED CHEMISTRY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE, MASS.

THE MECHANICAL MOVEMENT OF WATER THROUGH CERTAIN CLAYS AND ITS CONTROL[1,2]

By H. G. Schurecht

ABSTRACT

Introduction.—Ceramic bodies containing Georgia clay cast and release from the molds slower and have a greater tendency to crack in drying and burning than similar bodies containing English china clay. Experiments were conducted to improve these properties of Georgia clays by studying the movement of water through them and its control.

Permeability.—It was found that the permeability of the clays to water was independent of the time between 2 and 10 days; that is, P is nearly constant in the formula $P = \frac{W}{T}$, in which W is the total water which has passed through and T is the time in days. This factor for North Carolina kaolin was 1.55 ± .05; for English china clay 1.45 ± .06; for Georgia clay 0.938 ± .07; for South Carolina clay 0.673 ± .07; and for Tennessee ball clay 0.64 ± .08.

Capillarity.—The investigation showed that the capillary rise of water through these clays may be expressed by the formula $H = C_A(\log T - 1.041)$ in which H is the height attained by the water in time T, and C_A is approximately constant for each clay between 10 and 250 minutes, that is, it represents the movement of water through clay when it contains a certain amount of water below that required for saturation. This factor for North Carolina kaolin is 6.67 ± 0.30; for English china clay 7.30 ± 0.70; and for Georgia clay 4.66 ± 0.80. The great capillary conductivity of water through primary kaolins explains why bodies containing these get drier and release from the molds quicker than those containing secondary clays.

Methods for Improving Georgia Clay.—The permeability factor of Tennessee ball clay was increased from 0.64 to 1.20 by adding 0.7% NaOH, and that of kaolin from Dry Branch, Georgia increased from 0.938 to 1.72 by calcining to 450°C. By either, or a combination of the above treatments, it was possible to improve the properties of many Georgia clays, making them more like the English china clay in regard to permeability to water.

Introduction

Although the Georgia white clays have been successfully substituted for foreign kaolins in dust pressed ceramic bodies, the American potters still prefer the primary kaolins like the English china clay to the Georgia white clays for casting and jiggering. Our supply of high-grade primary kaolins is limited and not sufficient to supply the demand and, therefore, a very large part of such clays used in this country is imported from England.

The secondary white clays like those from Georgia, however, are very abundant, and if these can be substituted satisfactorily for English china clay, this country would be independent of foreign importations.

In utilizing Georgia clays in casting slips, it has been found that the slips cast and release from the molds much slower than those containing English china clay. This is due largely to the fact that the Georgia clays are finer

[1] By permission of the Director, U. S. Bureau of Mines.

[2] St. Louis Meeting, February 27, 1922.

in grain[1] than the English clays and, therefore, more resistant to the conductivity of water through them.

Still another objection to Georgia clay is that it cracks on drying and burning when moulded by the plastic process.

With the object of improving the working properties of Georgia clays, the writer made a study of the permeability and capillary movement of water through clays in both the plastic and dry states.

Experimental Methods

The permeability of clays to water was measured by means of the specially designed apparatus shown in Fig. 1. The clay or body to be tested in the plastic condition is mixed with water to normal consistency[2] and pressed into a cylindrical hole having 1 cm. diameter in the lower rubber stopper. Filter paper is sealed to the stopper above and below the clay by means of paraffin, to prevent the clay from mixing with the water. The cylinder is then filled to the 12.75 cm. mark with distilled water and the upper stopper with glass tube placed in position as shown.

The cylinders are weighed at the beginning of the test and at intervals up to 30 days, during which time they are kept in a constant temperature chamber. By determining the loss in weight at intervals, the amount of water passing through the clay may be calculated. Each time the cylinder is weighed it is refilled with water to the 12.75 cm. mark, thus keeping the water pressure approximately constant.

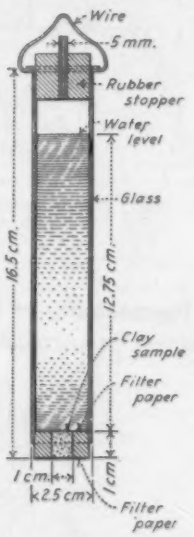


FIG. 1.—Apparatus for measuring the permeability of clays to water.

The capillary movement of water through clays was measured with the apparatus shown in Fig. 2. The raw unburned clay test piece is placed in the glass container where it rests on a piece of filter paper over a copper screen fastened across the bottom of the cylinder. The cylinder is then lowered into the cup, in which the water level is kept constant, until the bottom of the test piece touches the water. The glass cylinder containing the clay test piece is weighed before the test and at frequent intervals as a measure of the rate of absorption caused by the capillary rise of water.

[1] H. G. Schurecht, "The Microscopic Examination of the Mineral Constituents of Some American Kaolins," *Jour. Amer. Ceram. Soc.*, **5**, 3 (1922).

[2] By normal consistency is meant that consistency at which the clay contains a maximum amount of water without being sticky.

The height of the water is also measured at intervals. This is continued until the cylinder comes to constant weight. By adding a small amount of aniline dye to the water the height of the absorbed water may more plainly be seen.

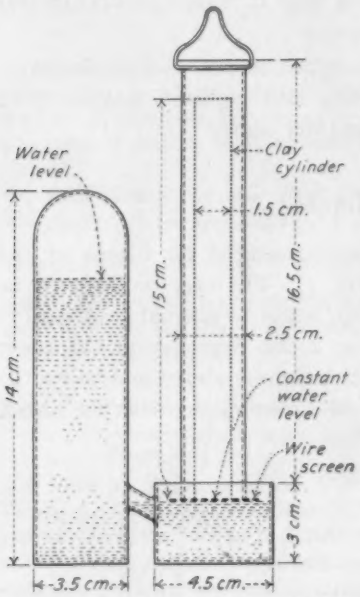


FIG. 2.—Apparatus for measuring the capillary rise of water through clays.

To study the effect of additions of varying amounts of NaOH on the permeability of clays, 0.1, 0.2, 0.3, 0.5, 0.7, 0.9, 1.2, 1.5, and 2.0% of NaOH were added to plastic clay samples and permeability tests were made according to the above method.

The effect of low calcination temperatures on the permeability of Georgia clays was studied by calcining the clays to 200°, 300°, 375°, 400°, 425°, 450°, 475°, 500°, 550°, and 600°C and holding them at these temperatures for one hour. Permeability tests as outlined above were then made on these samples.

Each clay sample contained a definite amount of water at the end of the test, which was also determined and expressed in terms of the dry weight of clay.

Experimental Results

Permeability of Clays to Water.—In Fig. 3 are shown the results of tests on the permeability of clays to water. It is obvious that North Carolina kaolins and English china clays are much more permeable to water than Georgia clays, South Carolina clays, and Tennessee ball clays. This,

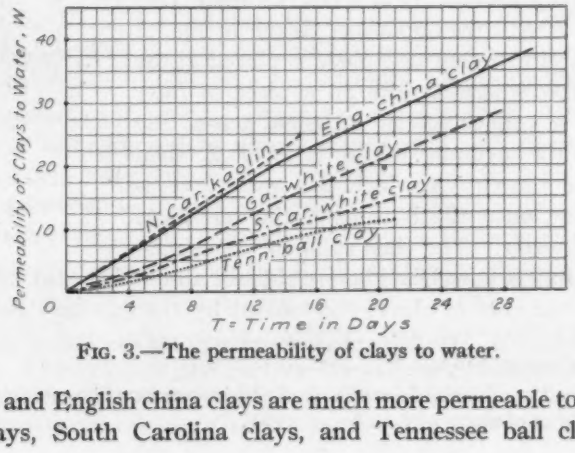


FIG. 3.—The permeability of clays to water.

therefore, explains why the primary clays like the English china clay and North Carolina kaolins produce faster casting bodies than the secondary clays like Georgia clay, South Carolina clay and Tennessee ball clay.

Between 2 and 10 days the permeability of clays to water may be approximately expressed by the following formula, which was derived from the data obtained in this work:

$$P = \frac{W}{T}$$

P = grams of water passing through 1 cm.^{3} of plastic clay in 1 day.
W = total grams of water passing through 1 cm.^{3} of plastic clay in time T.
T = time in days.
P is found to be approximately constant for each clay and was used to compare the permeability of different clays to water.

The permeability factors for the different clays are shown in Table I.

TABLE I

THE MECHANICAL MOVEMENT OF WATER THROUGH CLAYS

Clay	Permeability of clays to water: P—Grs. of H_2O passing through 1 cm.^{3} of plastic clay per day		Per cent water in clay at end of test	Capillary movement of water through clays: C_k capillary factor		C_w adsorption factor		Remarks
North Carolina kaolin	1.55*	0.05	54.2	6.67*	0.60	2.28*	0.30	Clay softened and deformed somewhat during the test.
English china clay	1.45*	.06	49.1	7.30*	.70	2.81*	.35	Clay softened only slightly during the test.
Georgia clay	0.938*	.07	41.9	4.66*	.80	1.83*	.40	Clay softened and deformed badly during the test.
South Carolina clay	0.673*	.07	32.3	...		...		...
Tenn. No. 7 ball clay	0.640*	.08	42.2	...		...		...

The per cent water in the clays at the end of the test is also shown in this table. It is obvious that the coarser grained clays contain a higher water content than the finer grained clays. This may be due largely to the fact that the per cent void space in the coarser grained clays is greater than in the finer grained clays.

Capillary Movement of Water through Clays.—In Fig. 4 and Table I are shown the results of the capillary movement of water through clays. This movement is faster through English china clay than through North

Carolina kaolin for the first 250 minutes. This may be due to the fact that North Carolina kaolin contains more of the extremely fine particles[1] than the English china clay which would fill the voids and retard the flow. The rate of capillary rise of water through the English china clay and North Carolina kaolin is greater than that through Georgia clay for the first 250 minutes and after this the rate becomes greater for the Georgia clay than for the primary clays.

Buckingham[2] in discussing the theory of capillary conductivity of water through soils states that the conductivity varies with decreasing water contents as follows: (1) the soils have the largest conductivity with a saturated water content and as the percentage of water decreases, the number of capillary paths become less and the conductivity decreases; (2) when most of the capillary paths have been broken, the film paths become important and there is a rather rapid decrease in capillary conductivity;

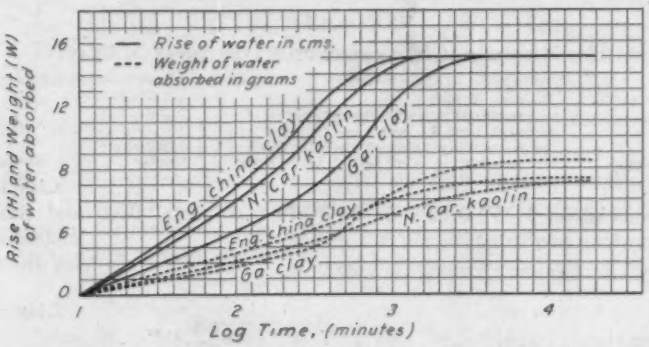


FIG. 4.—Capillary rise and weight of water absorbed.

(3) as the water content decreases the film paths change from short to long paths with a comparatively small decrease in conductivity; (4) as the soil approaches dryness, the films begin to break or lose the property of liquid water and there is a rapid decrease in capillary conductivity to zero.

Similar to what Buckingham claims for decreasing water contents, the writer found corresponding changes in the conductivity with increasing water contents. A rapid increase in conductivity in each clay was noticed for the first 10 minutes as the water content increased, which may be due to the rapid formation of a large number of water film paths. Then between 10 and 250 minutes the rate of rise of water is slower which would correspond to that period in which the long film paths change to short paths. Between 250 and 2000 minutes there is an increase in conductivity which

[1] H. G. Schurecht, "Sedimentation as a Means of Classifying Extremely Fine Clay Particles," *Jour. Amer. Ceram. Soc.*, **4**, 812–821 (1921).

[2] Edgar Buckingham, "Studies on the Movement of Soil Moisture," Bureau of Soils, *Bull.* **38** (1907).

according to Buckingham would represent that period in which the film paths change to capillary paths and after this period the rise is only slow until the clay becomes saturated. Between 10 and 250 minutes the rise of water may be approximately expressed by the following equations which were derived from the data obtained in this investigation:

$$C_h = \frac{H}{\log T - 1.041} \text{ or } H = C_h (\log T - 1.041),$$

C_h = capillary factor which is nearly constant for each clay.
H = height of water in cms. at different intervals of time.
T = time in minutes.

$$C_w = \frac{W}{\log T - 1.041} \text{ or } W = C_w (\log T - 1.041).$$

W = grams of water absorbed per cm.^{2} for different intervals of time.

Gardner and Widstoe[1] and Washburn[2] studied the capillary movement of water through soils and porous bodies and Washburn derived an expression in which the distance penetrated by a liquid flowing under capillary pressure in a horizontal capillary or one with a small internal surface is equal to the square root of $(\gamma\, rt \cos. \Theta/2n)$ in which γ is the surface tension, Θ the angle of contact, t the time, n the viscosity and r the radius of pores. Although an exact comparison between this expression and that derived from the data in this investigation are not possible because of insufficient data, the general shape of the curves derived are similar.

Although the movement of water through clays containing less than a saturated content is not essential to the speed of casting of a clay slip in a plaster mold, it becomes important after the slip has been poured from the mold and the water content in the casted shell decreases. During this stage the casted ware sticks to the mold until its water content becomes sufficiently low to prevent this stickiness. Those bodies containing clay from which the water moves rapidly reaches this stage before those containing clays from which the water is conducted slowly. Therefore, bodies of the former type will release and may be taken from the molds quicker than those of the latter type.

It was found in this work that the capillary movement of water through the primary clays is faster than that through secondary clays at certain stages when this content is decreased below saturation, and this may explain why bodies containing primary clays release and may be taken from the molds quicker than those containing secondary clays.

Between approximately 250 and 2000 minutes there is an increase in conductivity with an increase in time which may be due to the change from

[1] W. Gardner and J. A. Widstoe, "The Movement of Soil Moisture," *Soil Science*, 11, 215–232 (1911).

[2] E. W. Washburn, "The Dynamics of Capillary Flow," *Phys. Review*, 17, 273–283 (1921).

film to capillary paths as is explained above which is especially noticeable with Georgia clay. The capillary movement of water through Georgia clay is slower than that through English china clay and North Carolina kaolin for the first six hours, but after that it is faster than that through the primary kaolins and the final amount of water absorbed is also larger. The fact that water rises to a greater height in Georgia clay than it does in primary kaolins may be explained by examining the following equation:

$$H = \frac{2\,Y}{grd}$$

H = capillary height in cms.
g = 981, the gravitational acceleration in cms. ÷ sec.^{2}
r = radius of the capillary tube.
d = density of the liquid at the temperature of observation.
Y = surface tension in dryness per cm.

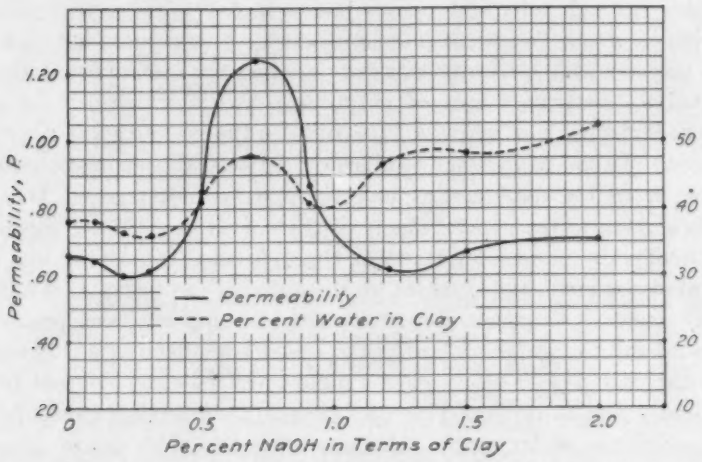


FIG. 5.—The effect of NaOH additions on the permeability of Tennessee ball clay to water.

In examining this formula it is obvious that the total height H is greater when the radius r is small. Since Georgia clays are much finer grained than the primary clays, the voids are smaller and hence r is much smaller, which causes the total height of absorbed water to be greater with Georgia clay than with the primary clays. A value varying with the average size of the pores may be calculated by noting the total height of water in the specimen. The resultant force causing the capillary flow of water through clays is evidently greater in the Georgia clays than in the primary clays because the value r is smaller in this case, but the higher resistance of Georgia clay to this flow causes the actual movement to be slower. After six hours the force of gravity on the water in the primary clays is so great

that the rise of water in the secondary clays becomes faster than that through the primary clays.

The bars prepared from Georgia and North Carolina clays deformed more than those of English china clay, due to softening. This is evidently caused by the larger percentage of extremely fine clay substance in the Georgia clays which restricted the flow of water, thereby causing the lower portion of the bar to become saturated with an excess of water and hence causing it to soften and deform.

The Effect of Addition of NaOH on the Permeability of Clays to Water.—The results of NaOH additions on the mechanical movement of water through clays is shown in Fig. 5. These results show that the permeability decreases when 0.2% of electrolyte is employed. Upon adding more NaOH there is a remarkable increase in permeability, this being much greater than the initial decrease. This increase is probably due to the fact that the clay is in a flocculated or partially flocculated condition, which causes the aggregates of fine particles to act as coarser grains and hence cause the mass to have larger voids between the aggregates.

It is therefore possible by adding the proper amount of electrolytes to secondary clays to make them as permeable to water as English china clay. Adding a percentage below that required for maximum flocculation, *i. e.*, less than 0.7%, would evidently give better results than are obtained by adding an amount causing maximum or minimum deflocculation, since bodies containing sufficient NaOH to cause maximum deflocculation cast in very thin layers while bodies containing sufficient NaOH to cause maximum flocculation do not drain clean and tend to stick to the mold.

The Effect of Low Calcination Temperatures on the Permeability of Clays to Water.—The results of low calcination temperatures on the permeability of clays to water are shown in Fig. 6. It is obvious that there is but little change in the effects produced by calcining at low temperatures until the clay is heated above 400°C. Here there is a sudden increase in permeability reaching a maximum at 450°C, and then it remains practically constant up to 600°C. This change occurs when the clay decreases in specific gravity[1] and is evidently closely related to the increase in volume of the clay which occurs at this temperature.

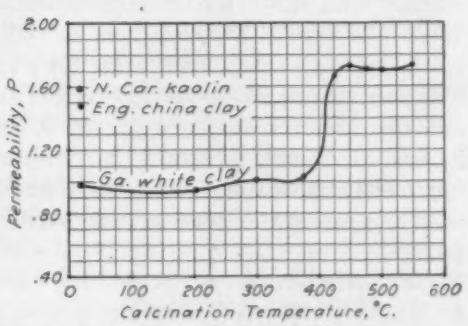


FIG. 6.—The effects of low calcination temperatures on the permeability of clay to water.

[1] J. M. Knote, "Some Chemical and Physical Changes Due to the Influence of Heat," *Trans. Amer. Ceram. Soc.*, **12**, 227–264 (1910).

The permeability of water through Georgia kaolin can be made greater by calcination than that through English china clay or North Carolina kaolin. Although the clay has lost some of its plasticity by being calcined at this temperature, it is still plastic, comparing favorably with the plasticity of English china clay. The tendency of Georgia kaolin to crack during drying is reduced. This was anticipated, since Bleininger[1] used the preheating method for improving the drying properties of joint clays which cracked badly in drying.

In comparing the permeability of Georgia clay calcined at 450°C with that of English china clay and North Carolina kaolin (see Fig. 7) it is found that it is greater than that for these clays. The permeability of the calcined clay does not revert back to that of the raw clay upon standing in

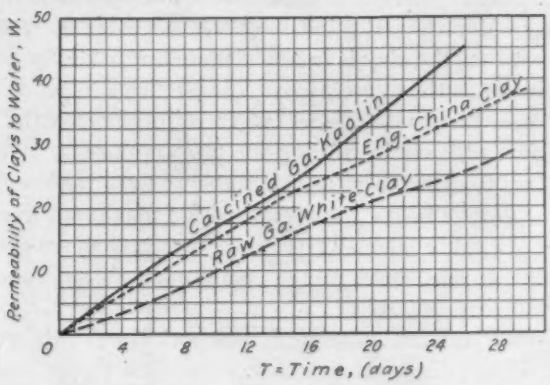


FIG. 7.—The permeability of calcined clay to water.

contact with water for 28 days as is shown by the permeability curve. We would expect, therefore, but a slight change in the permeability of calcined Georgia clay upon aging for a period of 28 days.

It may therefore be possible to treat Georgia clay by calcining at 450°C, and thereby overcome to a degree at least, its objectionable casting behavior. In conclusion the writer wishes to state that the above results are merely laboratory results and whether the above methods can be used successfully in practice will have to be determined by subsequent tests.

CERAMIC EXPERIMENT STATION
U. S. BUREAU OF MINES
COLUMBUS, OHIO

[1] A. V. Bleininger, "The Effect of Preliminary Heat Treatment upon Clay," *Trans. Amer. Ceram. Soc.*, **11**, 392–406 (1909).

USE OF OX GALL IN PREVENTION OF CRAWLING OF GLAZES

By H. Spurrier

ABSTRACT

The crawling of glazes may be entirely prevented by the use of ox gall in solution. The action is probably due to the lessened surface tension.

Some time ago, it was desired to glaze over an underglaze decoration in which the medium was oily so that a single fire might suffice instead of the usual two-fire method.

At first the prospect of success did not look very rosy and any effort in this direction seemed foredoomed to failure. It occurs, however, that artists sometimes use a preparation of ox gall to cause water colors to "take" on paper that has become greasy. Accordingly an ox gall preparation used for art purposes was secured and it was determined to try it out. The material was a light yellow limpid liquid, quite clear and without any fluorescence. A small quantity of this liquid was added to the glaze and the pieces were dipped, the glaze so treated covered well and gave promise of good results. The pieces were fired as usual and came out very well.

This circumstance led to an effort to find other materials that would do the work and not be so expensive as the artists' material.

Many and diverse materials were tried out and only one other was found that in any way served the purpose, and this none too well. The material was sulphonated castor oil also known as Turkey red oil or soluble oil. No further work was done in this connection for some three years, until recently. A bad case of "stripping" brought the former work to mind.

Owing to the presence of oil in dust-pressed ware, a certain colored glaze could not be made to cover, and the most aggravated stripping occurred in the kiln, rendering the pieces entirely unsuitable. In the meantime, a new source of ox gall was secured. This time the gall was in the paste form but very much cheaper, and is known as inspissated ox gall and was supplied by a large drug house in Detroit. On using this material such startlingly good results were obtained that some investigation was made in order to ascertain the underlying cause for the results.

It was noted that an aqueous solution of the material seemed to show a much lessened surface tension, and while this would undoubtedly help the aqueous glaze to cover the greasy or oily surface it was somewhat difficult to see how this should affect the firing behavior so strikingly. In order to test out the influence of the lessened surface tension, a cake of paraffin wax was dipped into a glaze containing a small quantity of the ox gall. On withdrawing the cake a thin even layer of glaze had become attached to the wax which was laid down flat to see if the film would "break." This however did not take place, and the glaze dried up completely having

covered the wax to the extreme edges and somewhat over the sides and ends. Moreover the dried residue was quite adherent, and when the thicker portions (which accumulate on withdrawing) were punctured with a pointed blade the glaze did not fly off as would be the case on ware.

A careful comparison of pieces of ware both with and without oil, glazed with the usual glaze, and with that containing ox gall, shows that the gall has the effect of producing a much more intimate bond between the glaze and the unfired body.

In no case, no matter how thick was the glaze on the body, could any hair cracks be seen with a × 10 Coddington lens.

In order to secure more information on the subject a letter addressed to Mr. H. C. Hamilton, research chemist with Parke, Davis & Co., who manufactured the ox gall, brought the information that they proceeded as directed in the U. S. Dispensatory where the following information is given.

"The composition is rather indefinite, and it is a mixture containing fats and coloring matter, along with the glycocholates and taurocholates of sodium and potassium." Mr. Hamilton suggests that "it may be that some obscure or unknown constituent is responsible for the peculiar action noted."

It is astonishing how small a quantity of ox gall will suffice to entirely stop the most aggravated cases of "crawling" as the following case in point will illustrate. A glaze batch of over two hundred pounds of solids of blue glaze was completely cured of severe crawling by the addition of three ounces of ox gall dissolved in part of the added water, in all the ware on which this glaze was used not a trace of crawling was to be found, whereas previously, no perfect specimens could be found. So far the only difference that can be detected, is the already noted close adherence of the glaze to the body and a rather smoother surface of the raw glaze when applied to dust pressed ware. As the addition of even a very small amount of ox gall to a glaze causes it to froth copiously in the mill, it is better to make the addition, after milling and lawning, by dissolving the required amount in a small quantity of water and gently stirring this solution into the glaze till thoroughly mixed.

It is not at all unlikely that further work on this subject will make it possible to develop a pure principle which will do the work of ox gall even more potently.

As ox gall preparations are highly complex, containing beside fatty matters, many bile acids, trypsin, cholesterol, etc., it might be possible to isolate those compounds which produce the desired effect. This seems the more likely as Ernst Joel in *Biochem. Zeitung* notes that glucose and acetone tend to reduce viscosity slightly, while bile serum reduces it to a much greater extent in secretory liquids.

SQUARE D CO.
PERU, IND.

THE WITCHERY OF GLAZES[1]

By Paul E. Cox

ABSTRACT

A paper showing the extent of research possible in glazes and the fascination of the work in that field. It is implied that the general chemist has little to offer to shorten the road that must be followed and that the work is reward enough for the labor involved. It is shown that the artistic temperament functions in this work along with the scientific temperament.

In the museum of the Louvre, in the section devoted to Egyptian ceramics, there is a scarab about the size of a man's hand. There are many hundreds of scarabs of many sizes all about this specimen but this one is peculiar in that it has been subjected to a reducing fire and the wings have developed the bronze color characteristic of copper-bearing glazes which have been fired in a strongly reducing atmosphere, while the body has touches of green, blue and red. The whole is very interesting to the student of color. No other specimen shows any such treatment and it would be entertaining to know exactly what happened in the mind of that craftsman when he took from his furnace this result which probably is better than the turquoise color which was sought. Doubtless another brain than the potter's decided that this one was of value, for the glaze maker is quite often too close to the job in hand to realize that accident often gives results more pleasing than those sought for, and a taste trained in another school quite often helps the craftsman to the step forward. Had there been several specimens of copper red glazed scarabs the conclusion would be that the Egyptians understood very well that process that later on made the lustred wares of Italy. But the single specimen makes speculation pleasant and a writer of the character of H. Rider Haggard might very well make a best seller story telling what things happened to the man who made a bronze and green scarab when a turquoise blue one was expected.

The chemist is concerned with the process by which the turquoise glaze can be produced and finds that copper in an alkaline glaze gives what is desired and that this glaze subjected to a smoky atmosphere will yield reds and coppery lustres. He furthermore finds that white sand bound with some of the glaze was the medium from which the scarabs were fashioned. If the chemist is an analyst only he may be satisfied to have established the proportions of the various ingredients, and the best process for getting his results. He may indicate his opinion as to how the reduction might be controlled today, but if he is also a ceramist he will marvel at the skill required to make so short a mixture as sand and glaze would have to be into the little figures that are so abundant among the things left from that civilization. And the ceramist will draw the lesson that if these objects could be glazed, together with some other kinds of things the Egyptians did, there are very few things that will stand fire that cannot be glazed if a

[1] Read at the meeting of the Exposition of Chemical Industries, New York, September, 1922.

glaze is wanted for them. And so the ceramist falls under the spell of the glaze witch.

The story of Bernard Palissy is too well-known to need more than mention to bring to the mind of every student of literature the point that it was the baffling character of the work that kept this more than ordinarily talented man digging away to an end that after all was not the thing he wanted to do but which gave him more fame than success in porcelain making possibly would have done. It was the witchery of the business that made him carry on, and the man is not so much known for his product as he is known for his yielding to the charm of glazes and ceramic colors.

Professor Chas. F. Binns used to tell his students that ceramics is more an art than a science and certainly this is true in the field of glaze making. Chemistry as known to the general chemist is of the greatest help to the ceramist, but nothing as yet has developed that makes it possible to do away with an empiric process of glaze development and hence there is always ahead of the experimenter the possibility of a combination of both scientific and artistic interest. It is the unknown that makes the drudgery of the work endurable, and few investigations fail to yield color variations, texture variations or some sort of differentiation from the beaten path that intrigues. The phrase maker might define art as the juggling with the infinite, and the artist as the one who does this. The glaze maker certainly is juggling with the infinite at all times. He must have, to be most successful, that sort of imagination that has developed within the modern school of painters (not the ultra modern). Such an imagination is necessary that will recognize effects applicable to terra cotta and other massive ceramics, as well as effects suitable for dainty pottery of the boudoir or dining room. In other words the glaze-making ceramist is successful in proportion to his culture, exactly as this is true in the field of art and for the same reasons. His imagination must be active and imagination is that thing which is stimulated by any works which may bewitch.

Time and temperature are the "Gold Dust Twins" that have long been recognized as factors in ceramic work, and the physicists and the physical chemists have worked to develop control of these factors in ceramic work. The enameled iron glaze maker will make an enamel that he can fire in half a minute but if he leaves it in the furnace a long time it is ruined. Glazes may be successful in a quick fire on light wares and useless on heavy wares in a long fire. It would be very simple to make glazes if we could say for example that the lime content varies directly as the temperature and inversely as the time, but we cannot because we have many other factors to take into account. If the glaze is used on a clay, the clay is being slowly dissolved and doubtless a glaze is a series of layers each merging into the other, the whole being the subject of spurts of flame and of cooler gases here and there over the surface so that control is difficult to imagine. We

hear of kilns that are to have slight variations top and bottom or side to side but we know that after all our glazes must be made up with the greatest flexibility as to variations in treatment if we are to produce results that we can market. It is this difficulty combined with the infinite varieties of glazes possible that form the pot of gold and the end of the ceramist's rainbow and keep him ever interested.

The common stoneware business has become senile for the same reason that John Barleycorn is legally dead. People became tired of the bother that whiskey made and one of the products made in the stoneware shop was jugs. So common and coarse a product as stoneware had the greatest interest in the glazes. Salt glaze is not easily handled, yet by the selection of clays and the manipulation of the kiln some of the best ceramic products are possible, a truth known long before anything like accurate chemical processes had been developed. The Martin art pottery of England is not surpassed so far as merit is concerned by any type of pottery made today and the difficulty of securing exactly the results desired must make the work of the greatest interest to the potters concerned. Technically the wares are common stoneware. No one has carried out the idea of making use of the slip clays for art pottery work though years ago Griffin suggested such a scheme, and showed how the slip clays might be modified to suit the needs of the artist to some degree. It is conceivable that by making use of slip clays only that a stoneware might be produced of the same warmth almost as the early Rookwood with its browns and yellows. A slip clay has recently been submitted to the writer that is said to yield a colorless or slightly yellow clear glaze and if tests show that to be true, this clay mixed with Albany slip clay and with Michigan or Seneca Falls slip clays and with one or two others known to the more mature of the stoneware men a rather interesting color palette would develop. This, if used on stoneware clays in the unfired state, would yield a technically very interesting art pottery. The fascination of such a work would be akin to any other research work in any field. And the difficulties would be abundant enough to stimulate interest quite like that shown by Palissy, though success would come with less starvation along the road than fell to that hero of ceramics.

The glazes of the type known as Bristol glazes have gotten into dignified company by having come into use in terra cotta work, but used in the manufacture of jugs and jars they were interesting to dabble with because slight variations in the proportions of the ingredients made such differences in the results. One manufacturer bought air separated whiting, thus having a material that was so fine it was almost a liquid. Glazes made up from this material did all sorts of things that made trouble and while he was not glad to lose his ware he enjoyed the knowledge he gained from the experience. A white Bristol glaze, made white by zinc oxide in

suspension can be cleared and made into a transparent glaze by the addition of flint or by the addition of lime, neither process making any appreciable difference in firing temperature needed to mature the glaze. Zinc oxide kills greens, lightens blues, makes crystals, and does many interesting things so that any glaze maker has on the one hand the temptation of cheapness prompting him to make use of glazes of the Bristol type and on the other hand the color problem to solve weighing against such use. This has developed several papers showing results of research that point out how interesting such research can be.

Karl Langenbeck in his "Chemistry of Pottery" points out that it is impossible to cover the possibilities of any glaze by any single statement of its composition because of the influence of the otherwise colorless ingredients of the glaze on the chromatics. That is, a statement of the composition of a colorless glaze can be given but trial must be had before a statement of what this glaze will look like for every stain added to it. Or a glaze may have a certain color but for some reason a change may be thought desirable in the ingredients that would with no colorant present produce a colorless glaze and a vital change in the color of the glaze would result. It is necessary therefore always to test out such work and to adjust for each change made. Such procedure demands exact work that is interesting indeed. Changes of temperature from top to bottom of the kiln likewise affect the tints and often the glaze has to be adjusted to meet these conditions.

Texture is likewise profoundly influenced by the variations of the ingredients in a glaze and the European potter has been careful to state the source of his raw material as well as the chemical composition of it, because he knows that the physical conditions have influence quite as much perhaps as the chemical conditions. Because of these facts there are times when a recipe is worth keeping secret and it can be kept secret by failure to report the source of raw materials.

Defects have been made into virtues in the potter's craft from time immemorial, and we have but to note how crazing properly taken advantage of has made more than one type of pottery glaze of the greatest interest.

The glaze maker has a wide field for his work. There is true porcelain fired in these days to almost any temperature possible to obtain sagger mixtures refractory enough to permit temperature. The color palette is limited at high temperatures but there is ample incentive for investigation at high temperatures for aesthetic reasons as well as for reasons of science. Any person working with a really capable artist will find that the artist finds pleasure backed with good reasons in the qualities of glaze and color due to high temperatures and those admirable volumes by Burton on porcelains point out constantly what an important part the glaze maker has played in the production of quality porcelains through the ages. The

literature of ceramics tells of the beauty of body and glaze of the soft porcelains but we have done little in America with this interesting type of porcelain if we except Beleek made in Trenton. America has not yet made bone china of any great merit or amount and there will be adaptations of English practice to American materials when this kind of ware is developed here. Our domestic whitewares will lend themselves to treatments in colored glazes and though it may be suggested that the use of colored glazes on white bodies is wasteful the ceramist knows that certain kinds of bodies yield refinements in glazes that make the expenditure worth while. Any worker in glazes who has made use of the little floor tiles that are so hard and are feldspathic knows that the quality of glaze is superior to the glaze obtained on coarser bodies.

Our secondary fire clays have been made use of but slightly in the making of fine stonewares. Chas. F. Binns has done more with them than any other worker and he is not engaged in commercial life so that few people know that work of the type he has done brings out the maximum beauty of our very abundant stoneware clays. He has by no means exhausted the opportunities for work with these clays and a lifetime of interesting investigation could be devoted to stoneware alone. The writer would say that stoneware might be better suited to our cold country than the porcelains, and these fine stonewares are always recognized as of the same high class as hard porcelains.

The term faïence has been accepted as covering a wide field that possibly might be narrowed into a field covered in Europe by the tin enameled wares at one time. We have so many types of wares that look somewhat alike but that are made at widely differing temperatures, all made from relatively coarse clays, with every type of glaze almost that can be thought of. It is in this field that the glaze maker can go his limit and he can produce warm or cold colors, brilliant or mat glazes, crystalline or amorphous glazes, anything he can find pleasure in making. It is in this type of ware the amateur finds it easy to secure adequate help from the literature and from the dealers in supplies, and since the temperatures are usually low the portable kiln is satisfactory. Any person who has had elementary chemistry can understand readily the methods used by the ceramist to develop his glazes and the field is open to any graduate of the high schools that offer chemistry, and to most college students who have had the Freshman year.

The precipitations in the tube of the chemist's laboratory show glories of colors and demand thoughtful consideration. The glazed test pieces, tiles or what not, are the test tubes of the ceramist and when series after series are run, covering every variation that can be thought of, a considerable knowledge of the properties of the complex mixtures can be had and while the reaction cannot be written out, X plus Y equals A plus B, never-

theless a very definite idea of what will happen when the same mixture is again made can be obtained and a very definite idea of what will make disaster can likewise be gained. Men like Binns and Burt and Rhead know as definitely as any chemist what to expect from certain mixings of their materials and the writer would declare that a qualitative analysis could be developed, if worth doing, dealing entirely with melted glazes, determining by fire and reagents dropped on the glazed surfaces the qualitative composition of glazes by the changes in color of either the reagent or the glaze itself.

These are some of the things that are the witcheries of glazes.

CERAMICS DEPARTMENT
IOWA STATE COLLEGE
AMES, IOWA

AUTHOR INDEX TO JOURNAL

The reference number in parentheses refers to the *monthly* number of the *Journal;* the number following this is the page number. The letters O, D or E preceding reference number indicate that the articles are Original (O), Discussion (D) or Editorial (E).

A list of the abbreviations used in the Index is found on page 381, *Ceramic Abstracts.*

VOLUME 5

Albery, D. F. Use of pulsichrome from mfgr.'s standpoint, D (11) 828–29.
Arnold, H. C. Manuf. of single coat gray enameled ware, O (12) 858.
Ayars, E. E. Molds for magnesite, chrome and silica brick, O (2) 67.

Ball, A. P. Economic handling of mats. in porcelain manuf., O (5) 235.
Bellamy, H. T. A small glass tank, O (3) 157.
Binns, C. F. and Burdick, T., Low-fire porcelain, O (1) 25.
Bitting, A. W. Glass containers, O (2) 85.
Bole, G. A. Mechanism of plasticity from colloid standpoint, O (8) 469.
Bole, G. A. See Shaw, J. B.
Bole, G. A. and Shaw, J. B. Caustic calcination of dolomite and its use in sorrel cements, O (11) 817.
Brand, J. J. Lamination, discussion of cause and cure, O (6) 355, D (6) 371, 374.
Broga, W. C. and Hudson, C. J. Convenient instrument for making shrinkage meas., O (1) 34.
Buckingham, A. W. Data on opern. of continuous tunnel kiln at plant of A. C. Spark Plug Co., D (6) 274.
Bunting, E. N. Note on effect on manganese in glass melted under reduced press., O (9) 594, D (9) 594–5; Simplified method of detg. dry vol. of clay briquettes, D (7) 396.
See Washburn, E. W.
Burdick, T. See Binns, C. F.

Cable, M. K. Development of ceram. work at Univ. of N. D., O (3) 140.
Carlsson, F. See Sieurin, E.
Carpenter, J. W. Developments in 1921 in elec. vitreous enameling fur., O (7) 409.
Carruthers, J. L. Notes on shivering of terra cotta, O (8) 518; Use of forced draft for terra cotta kilns, O (7) 449.
Clare, R. L. Effect of fluxes on absorption and transverse strength of terra cotta body, D (11) 835.
Clark, E. Use of pulsichrome from mfgr.'s standpoint, O (11) 826, D (11) 828.
Clark, H. H. New type of gas-fired vitreous enameling fur., O (8) 478.
Clark, J. Good and bad practice in pressing dept., D (9) 641–2, Pressing terra cotta, O (9) 623.
Clark, W. M. and Forsyth, J. H. Handling, storing and setting of glass pots, O (3) 146.
Cox, P. E. Witchery of glazes, O (12) 938.
Cramer, W. E. Harrop tunnel kiln, O (8) 492.
Crawford, J. L. Simplified method of detg. dry vol. of clay briquettes, O (7) 394.

Danielson, R. R. Observations of fish-scaling of ground-coat enamels, D (9) 621.
Danielson, R. R. and Reinecker, H. P. Wet process enamels for cast iron, O (10) 648, D (10) 669.
Davis, H. E. Data on viscosity of Ind. clay slip with electrolytes in regard to casting of terra cotta, O (10) 702, D (10) 710–11; Use of pulsichrome from mfgr.'s standpoint, etc., D (11) 829.
Davis, N. B. Derry feldspar quarry, O (6) 294.
Dixon, H. L. Passing of King Methane, D (10) 697–8, 700.

Endell, K. H. Comparison of hot and cold modulus of rupture, D (12) 897; Testing of silica brick, O (4) 209.

Farnham, D. T. Cost system as aid to efficient plant control, O (1) 43; Reduction of indus. wastes, O (7) 440.
Ferguson, R. F. See Howe, R. M.
Ferrand, G. Ceram. art and architecture, O (11) 744, D (11) 749, 751, 754–56.
Ford, K. L. Weathering of glass containers, O (12) 837.
Forsyth, J. H. Note on effect on manganese in glass melted under reduced press., D (9) 595.
Forsyth, J. H. See Clark, W. M.
Foster, H. D. Effectiveness of different methods of making detns. as applied to hollow bldg. tile, O (11) 788.
Frazier, C. E. Opern. of leers, O (1) 37.

Garve, T. W. Stability and design of kiln stack, O (7) 455.
Gates, M. E. Ceram. art and architecture, D (11) 751, 754, 757.
Gates, W. D. Data on viscosity of Ind. clay slip with electrolytes in regard to casting of terra cotta, D (10) 709–10; Good and bad practice in pressing dept., D (9) 640–41; Use of pulsichrome from mfgr.'s standpoint, D (11) 828.
Geisinger, E. E. Expt. in elec. smelting glass enamels, O (5) 248; Microscopic study of ground-coat and cover-coat enamel reaction, O (6) 322; Observations of fishscaling of ground-coat enamels, D (9) 621.
Gladding, A. L. Use of pulsichrome from mfgr.'s standpoint, D (11) 829.
Grainer, J. S. Observations on factory control of fishscaling, O (2) 95.
Greaves-Walker, A. F. Comparison of hot and cold modulus of rupture, D (12) 897-900; Data on opern. of continuous tunnel kiln at plant of A. C. Spark Plug Co., D (6) 274.
See Kier, S. M.

Hain, V. A. Developments in 1921 in elec. vitreous enameling fur., D (7) 415–16.
Hall, F. P. Plasticity of clays, O (6) 346.
See Wilson, R. E.
Hansen, J. E. Modification of empirical formula in glaze and enamel calcn., O (6) 338.
Harlow, J. E. Heat transmission with ref. to stoker-fired boiler, D (7) 423.
Harrop, C. B. Data on opern. of continuous tunnel kiln at plant of A. C. Spark Plug Co., D (6) 273.
Harvey, F. A. Comparison of hot and cold modulus of rupture, D (12) 897–900.
Harvey, F. A. and McGee, E. N. Testing of silica brick, D (4) 218.
Helser, P. D. See McDowell, S. J.
Hess, H. Passing of King Methane, D (10) 698.
Hill, C. W. Data on viscosity of Ind. clay slip with electrolytes in regard to casting of terra cotta, D (10) 710–12; Effect of fluxes on absorption and transverse strength of terra cotta body, O (11) 835; Terra cotta probs. suggested for discussion and investigation, O (10) 732.
Hill, E. C. Ceram. art and architecture, D (11) 749, 757; Effect of some fluxes on absorption nd transverse strength of terra cotta body,

O (11) 832; Some expts. on firecracking of terra cotta, O (6) 299.
Horning, R. A. Lamination, discussion of cause and cure, D (6) 374.
Hostetter, J. C. Note on effect on manganese in glass melted under reduced press., D (9) 594–5; Passing of King Methane, D (10) 697–700.
Hottinger, A. F. Effect of fluxes on absorption and transverse strength of terra cotta body, D (11) 835.
Howe, R. M. Ht. transmission with ref. to stoker-fired boiler, D (7) 428.
Howe, R. M. and Kerr, W. R. Influence of grind and burn on charac. of silica brick., O (4) 164.
Howe, R. M. and Phelps, S. M. Ht. transmission with ref. to stoker-fired boiler, O (7) 420.
Howe, R. M., Phelps, S. M. and Ferguson, R. F. Effect of weather upon strength of refrac. brick, O (2) 107.
Hudson, C. J. See Broga, W. C.
Hull, W. A. Comparison of hot and cold modulus of rupture for silica brick, D (12) 899.

Ittner, W. W. Water-smoking with induced draft, O (10) 721, D (10) 730.

Jaeger, F. G. Developments in 1921 in elec. vitreous enameling fur., D (7) 416.

Kallstedt, C. H. Developments in 1921 in elec. vitreous enameling fur., D (7) 417.
Kerr, W. R. See Howe, R. M.
Kier, S. M. and Greaves-Walker, A. F. Preliminary Rept. of Comm. on fuel conservation on R. R. tunnel kiln, O (9) 602.
King, E. O. Mfg. clay products 14,000 ft. above sea level, O (10) 739.
Klinefelter, T. A. Good and bad practice in pressing dept., O (9) 632, D (9) 641.
Kruson, J. H. Refrac. clays of Texas, O (9) 643.

Laird, J. S. See Riddle, F. H.
Landrum, R. D. Seven conventions in one, E (2) 65.
Libman, E. E. Some properties of zinc oxide bodies, O (8) 488.
Lindemann, W. C. Developments in 1921 in elec. vitreous enameling fur., D (7) 415–6, 418.
Loomis, G. A. Phys. defects in tank blocks, O (2) 102.
Lovejoy, E. Lamination, discussion of cause and cure, D (6) 372.

MacMichael, P. S. Use of pulsichrome from mfgr's. standpoint, D (11) 828.
Mahoney, F. B. Developments in 1921 in elec. vitreous enameling fur., D (7) 419.
Malinovszky, A. Wet process enamels for cast iron, D (10) 669.
Manson, M. E. Effect of sources of pig iron upon enameling of cast iron, O (11) 806; Reln. of fineness of grinding to opacity in white enamels, D (12) 857.
McCullough, E. W. Reduction of varieties in manufd. products, O (5) 221.
McDowell, J. S. and Robertson, H. S. Chrome refrac., O (12) 865.
McDowell, S. J. and Helser, P. D. Data on opern. of continuous tunnel kiln at plant of A. C. Spark Plug Co., O (6) 267.
McGee, E. N. Comparison of hot and cold modulus of rupture for silica brick, O (12) 888, D (12) 897.
McGee, E. N. See Harvey, F. A.
Minton, R. H. Effect of fluxes on absorption and transverse strength of terra cotta body, D (11) 835.
Morey, G. W. Notes on diagnosing causes of cords in glass, D (6) 293.
Moulton, D. A. Note on ladle brick, O (11) 823; Oil-fired fur. for plant lab., O (10) 713.
Munshaw, L. M. II. Pulsichrometer vs. old method of applying glazes, O (11) 827.

Navias, L. See Washburn, E. W.
Nicholls, P. Ht. transm. with special ref. to stoker-fired boiler, D (7) 424.

Ortman, F. B. Data on viscosity of Ind. clay slip with electrolytes in regard to casting of terra cotta, D (10) 711; Good and bad practice in pressing dept., D (9) 640–41; Use of pulsichrome from mfgr.'s standpoint, D (11) 829.

Parmelee, C. W. Refrac. clays of Ill., O (10) 685; Sol. salts and clay wares, O (8) 538.
Parsons, F. C. See Klinefelter, T. A.
Peters, M. F. Carborundum brick, O (4) 180.
Phelps, S. M. See Howe, R. M.
Pike, R. D. Need for more refrac. ht. insulators, O (8) 554.
Poste, E. P. Developments in 1921 in elec. vitreous enameling fur., (7) 416, 418–9; Relative merit of ht. resisting alloys for enamel burning racks, O (11) 811; Reln. of fineness of grinding to opacity in white enamels, D (12) 857.
Prince, E. S. Reln. of fineness of grinding to opacity in white enamels, D (12) 857.
Prince, E. S. See Sweely, B. T.
Purdy, R. C. Mech. of plasticity from colloid standpoint, D (8) 475; The season's greetings, E (1) 1.

Reinecker, H. P. See Danielson, R. R.
Rhead, F. H. Art Div. of Amer. Ceram. Soc., E (2) 57; Ceram. art and architecture, D (11) 750, 757; Organization of decorative ceram. research dept., O (11) 758; Painting in underglaze colors on biscuit, O (6) 376. Types of glazes suitable for decorative inlay processes, O (5) 259.
Richardson, W. D. Adaptability of gas-fired compartment kiln for burning of clay products, O (5) 254; Lamination, discussion of cause and cure, D (6) 369.
Riddle, F. H. and Laird, J. S. Control of glaze-fit by means of tensile test specimens, O (8) 500; Tensile strength of porcelain, O (7) 385.
Ries, H. Fire clays of eastern coalfield of Ky., O (7) 397.
Riess, D. F. Developments in 1921 in elec. vitreous enameling fur., D (7) 417–8.
Robertson, H. S. See McDowell, J. S.
Robson, J. T. Influence of ht. on microscopic properties of silica in diff. mineral forms, O (10) 670.
Ross, D. W. Passing of King Methane, D (10) 700; Comparison of hot and cold modulus of rupture for silica brick, D (12) 900.

Scholes, S. R. Passing of King Methane, O (10) 693.
Schramm, E. Device for testing resist. of china to chipping, O (3) 136.
Schurecht, H. G. Mech. movement of water through certain clays and its control, O (12) 928; Microscopic examn. of mineral constituents of some Amer. clays, O (1) 3.
Shaw, J. B. and Bole, G. A. New developments in oxychloride stucco and flooring, O (6) 311.
Shaw J. B. See Bole, G. A.
Sheerer, M. G. Painting in underglaze colors on the biscuit D (6) 383.
Sheffield, A. H. Ceram. art and architecture, D (11) 749, 755–57.
Shoemaker, G. W. Lamination, discussion of cause and cure, D (6) 375.
Sieurin, E. and Carlsson, F. Resist. tests on fire bricks under load at high temp., O (4) 170.
Smith, C. D. Passing of King Methane, O (10) 701.
Sortwell, H. H. A simplified method of detg. dry vol. of clay briquettes, D (7) 396; Comparative tests of Amer. and foreign tableware, O (6) 276.
Sprosat, I. E. Control of biscuit losses, O (9) 588.
Spurrier, H. An improved magnet box, O (9) 586; Investigation of dust press practice as

influencing finished sizes and cracking, O (11) 798; Suggested new methods in prepn. of dust-pressed bodies, O (3) 151; Use of ox gall in prevention of crawling of glazes, O (12) 937.
Staley, H. F. Developments in 1921 in elec. vitreous enameling fur., D (7) 418.
Stone, G. C. Refrac. for zinc smelting, O (9) 597.
Sweely, B. T. Developments in 1921 in elec. vitreous enameling fur., D (7) 416–419; Observations of fishscaling of ground coat enamels, O (9) 618, D (9) 620–21.
Sweely, B. T. and Prince, E. S. Reln. of fineness of grinding to opacity in white enamels, O (12) 855; Reln. of compn. to thermal shock in steel enamels, O (5) 263; Wet process enamels for cast iron, D (10) 669.

Tefft, C. F. Water-smoking with induced draft, D (10) 730–31.
Thurliman, L. A. Data on viscosity of Ind. clay slip with electrolytes in regard to casting of terra cotta, D (10) 710–11.
Tillotson, E. W. Note on effect on manganese in glass melted under reduced press., D (9) 595.
Tucker, G. M. Good and bad practice in pressing dept., D (9) 641; Use of pulsichrome from mfgr's. standpoint, etc., D (11) 828.
Twells, Robt., Jr. Beryl as a constituent in high tension porcelain, O (5) 228; Field of porcelain glazes maturing between cones 17 and 20, O (7) 430; Talc as flux for high tension insulator porcelain, O (10) 675.
Twyman, F. Notes on diagnosing causes of cords in glass, O (6) 289.

Washburn, E. W. Some properties of zinc oxide bodies, D (8) 490; Simplified method of detg. dry vol. of clay briquettes, D (7) 396.
Washburn, E. W. and Bunting, E. N. Porosity V: Recommended procedures for detg. porosity by methods of absorption, O (1) 48; Porosity: VI. Detn. of porosity by method of gas expansion, O (2) 112; Porosity: VII Detn. of porosity of highly vitrified bodies, O (8) 527.
Washburn, E. W. and Navias, L. Products of calcination of flint and chalcedony, O (9) 565.
Watkins, R. T. Degree to which different glaze compns. take vapor lusters, O (1) 28.
Wells, R. D. Reln. of fineness of grinding to opacity in white enamels, D (12) 857.
Wenning, W. F. Developments in 1921 in elec. vitreous enameling fur., D (7) 419.
Whitten. Comparison of hot and cold modulus of rupture for silica brick, D (12) 896.
Wiester, S. Observations of fishscaling of ground coat enamels, D (9) 620; Wet process enamels for cast iron, D (10) 669.
Williams, A. E. Disintegration of soda lime glasses in water, O (8) 504; Passing of King Methane, D (10) 698, 701.
Williams, A. E. and Woods, B. J. Comparative tests of Eng. and domestic whitings, O (12) 901.
Wilson, R. E. and Hall, F. P. Measurement of plasticity of clay slips, O (12) 916.
Woods, B. J. See Williams, A. E.
Wright, J. W. Note on effect on manganese in glass melted under reduced pressure, D (9) 594.

Yung, W. A. Passing of King Methane, D (10) 699.

SUBJECT INDEX TO JOURNAL

Absorption, detn. of porosity by methods of, (1) 48.
detns. of hollow building tile, different methods of making, (11) 788.
Alloys, heat resisting for enamel burning racks, relative merit of, (11) 811.
Architecture, ceram. art and, (11) 743.
Art, ceram., and architecture, (11) 743.

Balz continuous tunnel kiln, (9) 610.
Beryl as a constituent in high tension insulator porcelain, (5) 228.
Bingham plastometer, meas. of plasticity of clay slips by, (6) 350, (12) 916.
Biscuit losses, control of, by transverse strength tests, (9) 588.
Blocks, phys. defects in tank, (2) 102.
Brick, effect of weather upon the strength of refrac., (2) 107.
fire. See Fire brick.
ladle, tests for, (11) 823.
molds for magnesia, chrome and silica, (2) 67.
porosity meas. on full size, (8) 535.
silica. See Silica brick.

Calcium chloride-dolomite cements for stucco and flooring, (6) 311.
Capillary rise of water through clays, (12) 928.
Carborundum brick, (4) 181.
clay proportions for, (4) 184.
fabrication of, (4) 193.
methods for testing, (4) 186.
Cast iron enameling, effect of sources of pig iron upon, (11) 806.
wet process enamels for, (10) 647.
cover enamels, (10) 647.
ground coats, (10) 647.
Cements, dolomite-calcium chloride for stucco and flooring, (6) 311.
magnesium chloride for stucco and flooring, (6) 311.
Sorrel, use of calcined dolomite in, (11) 817.
Ceramic art and architecture, (11) 743.
research department, organization of a decorative, (11) 758.
work at the University of North Dakota, the development of, (3) 140.
Chalcedony, a form of colloidal quartz, (9) 565.
influence of heat on microscopic properties of, (10) 670.
phys. properties, thermal expansion and X-ray spectrum of, (9) 565.
products of the calcination of, (9) 565.
Champion continuous tunnel kiln, (9) 610.
China, a device for testing the resist. to chipping of, (3) 137.
hotel, comparative tests on Amer. and foreign, (6) 276.
Chipping resist. of china, pendulum impact device for testing, (3) 137.
Chrome brick, molds for, (2) 67.
refractories, properties of, and bibliography on (12) 865.
Chromite refractories, properties of, and bibliography on, (12) 865.
Clay briquettes, simplified method of detg. dry vol. of, (7) 394.
laminations in, differential and interfacial (6) 355.
products manufd. 14,000 ft. above sea level (Andes Mountains), (10) 739.
slip, Indiana, viscosity of for casting terra cotta, (10) 702.
slips, meas. of plasticity of, (12) 916.
wares, sol. salts and, (8) 538.
Clays, capillary rise of water through, (12) 928.
effect of, on firecracking of terra cotta, (6) 299.
fire, of the E. coalfield of Ky., (7) 397.
mech. movement of water through, (12) 928.
microscopic examn. of the min. constituents of English china clays, (1) 5.
examn. of the min. constituents of some Amer. clays, (1) 3.
permeability of, to water, (12) 928.
plasticity of, (6) 346.
refrac., of Illinois, (10) 685.
of Texas, (9) 643.
Colloids and mechanism of plasticity, (8) 469.
Colors, underglaze and liquid underglaze, compns. of, (6) 377.
underglaze, painting on the biscuit, (6) 376.
Conductometer, proposed, for measg. thermal condy., (8) 554.
Containers, glass, (2) 85.
Cooling rate, effect of, on firecracking of terra cotta, (6) 299.
Cords in glass, diagnosing, (6) 289.
Cost system as an aid to efficient plant control, (1) 43.
Cover enamels for cast iron, by wet process, (10) 647.
Crawling of glazes, use of ox gall in preventing, (12) 937.
Crazing tests on Amer. and foreign table ware, (6) 279.
Cristobalite and quartz in silica brick, photomicrographic estn. of, (4) 207.
phys. properties, thermal expansion and X-ray spectrum of, (9) 565.

Decorative ceram. research department, organization of, (11) 758.
Derry Feldspar Quarry, (6) 294.
Didier-March Continuous Tunnel Kiln, (9) 614.
Disintegration of soda lime glasses in water, (8) 504.
Dolomite, calcined, used in Sorrel cements, (11) 817.
calcined, used in stucco, (11) 820.
calcium chloride cements for stucco and flooring, (6) 311.
caustic calcination of, (11) 817.
magnesium chloride cements for stucco and flooring, (6) 311.
Draft, forced, for terra cotta kilns, (7) 449.
induced, water smoking with, (10) 721.
Dressler continuous tunnel kiln, (9) 609.
Dust-pressed bodies, factors affecting finished sizes and cracking, (11) 798.
new methods in the prepn. of, (3) 150.

Editorials. Abstracts from the Journal of the Japanese Ceramic Society, (3) 135.
The art division of the American Ceramic Society, (2) 57.
The Chemistry and Physics of High Temps., (4) 161.
1922 convention a record, (4) 162.
The Season's Greetings. What shall they be? (1) 1.
The second conference of the International Union of Pure and Applied Chemistry, (3) 131.
Seven conventions in one, (2) 65.
Efflorescence on clay wares, (8) 538.
Electrical porcelain, porosity of, (8) 532.
Electric vitreous enameling fur., developments in 1921, (7) 409.
Emley plasticimeter, (6) 349.
Enamel burning racks, relative merit of heat resisting alloys, (11) 811.
calcns., modification of the empirical formula in, (6) 338.
glass, elec. smelting of, (5) 248.
reactions, ground coat and cover coat, microscopic study of, (6) 322.
Enameled ware, manuf. of single coat gray, (12) 858.
Enameling fur., gas-fired vitreous, (8) 478.
observations on the factory control of fishscaling, (2) 95.
of cast iron, effect of sources of pig iron upon, (11) 806.
vitreous elec. fur., developments in 1921, (7) 409.
Enamels, ground coat, fishscaling of, (9) 618.

steel, relation of compn. to thermal shock, (5) 263.
wet process, for cast iron, (10) 647.
white, relation of fineness of grinding to opacity in, (12) 855.

Feldspar Quarry, Derry, (6) 294.
Fire brick, effect of weather upon the strength of, (2) 107.
clays of the E. coalfield of Ky., (7) 397.
resist. tests under load at high temps. on, (4) 171.
Firecracking of terra cotta, expts. on, (6) 299.
Fish-scaling, observations on the factory control of, (2) 95.
of ground coat enamels, (9) 618.
Flint, a form of colloidal quartz, (9) 565.
influence of heat on microscopic properties of, (10) 670.
phys. properties, thermal expansion and X-ray spectrum of, (9) 565.
products of the calcination of, (9) 565.
Flooring, oxychloride, new development in, (6) 311.
Formula, mol. new type for glaze and enamel calcns., (6) 338.
Fuel conservation in the railroad tunnel kiln (continuous car tunnel kiln), (9) 602.
Furnace, gas-fired vitreous enameling, (8) 478.
oil-fired, for the plant lab., (10) 713.
Furnaces, elec. vitreous enameling, developments in 1921, (7) 409.

Gas-fired vitreous enameling fur., (8) 478.
Glass containers, general discussion on, (2) 85.
containers, weathering of, (12) 837.
diagnosing cords in, (6) 289.
enamel, elec. smelting of, (5) 248.
melted under reduced press., effect on manganese (oxides) in, (9) 594.
pots, handling, storing and setting of, (3) 147.
tank, a small, (3) 157.
Glasses, soda lime, disintegration of, (8) 504.
Glaze application by pulsichrometer method, (11) 826.
calcns., modifications of the empirical formula in, (6) 338.
compns., taking good vapor lusters, (1) 28.
fit control, by means of tensile test specimens, (8) 500.
low fire porcelain, (1) 27.
Glazes, crawling of, use of ox gall in preventing, (12) 937.
porcelain, maturing between cones 17 and 20, (7) 430.
suitable for decorative inlay processes, (5) 259.
the witchery of, (12) 939.
white transparent, compns. of, (6) 381.
Grinding, fineness of, relation of to opacity in white enamels, (12) 855.
Grog size, effect of, on firecracking of terra cotta, (6) 299.
Ground coats for wet process enamels for cast iron, (10) 647.

Harrop continuous tunnel kiln, (8) 492, (9) 614.
Heat insulators, refrac., need for more, (8) 554.
resisting alloys, relative merit of, for enamel burning racks, (11) 811.
transmission, with special ref. to the stoker-fired boiler, (7) 420.
Hotel ware, comparative tests on Amer. and foreign, (6) 276.
Household ware, comparative tests on Amer. and foreign, (6) 276.

Illinois, refrac. clays of, (10) 685.
Impact pendulum test for resist. to chipping of china and porcelain, (3) 137.
tests on Amer. and foreign tableware, (6) 283.
Indiana clay slip for terra cotta casting, viscosity of, (10) 702.
Industrial wastes, reduction of, (7) 440.
Inlay processes, decorative, type of glazes suitable for, (5) 259.
Insulators, refrac. heat, need for more, (8) 554.
Iridescent vapor lusters, (1) 28.
Iron, cast, effect of sources of pig iron upon the enameling of, (11) 806.
pig, effect of sources of upon enameling of cast iron, (11) 806.

Kentucky, fire clays of the E. coalfield, (7) 397.
Kiln, compartment, adaptability for burning clay products of, (5) 254.
continuous tunnel, at plant of A. C. Spark Plug Co., (6) 267.
Champion or Balz, (9) 610.
Didier-March, (9) 614.
Dressler, (9) 609.
Farber, (9) 613.
Harrop, (8) 492, (9) 614.
railroad or continuous car, fuel conservation in, (9) 602.
stack, stability and design, (7) 455.
Kilns, terra cotta, forced draft for, (7) 449.

Ladle brick, tests for, (11) 823.
Laminations in clay, differential and interfacial, (6) 355.
Leers, opern. of muffle and open types, (1) 37.
Load test app., Steger, (4) 209.
Lusters, vapor, glaze compns. taking good, (1) 28.

MacMichael torsional viscosimeter, (6) 348.
Magnesia brick, effect of weather upon the strength of, (2) 107.
molds for, (2) 67.
Magnesium chloride-dolomite cements for stucco and flooring, (6) 311.
Magnet box, improved, (9) 586.
Manganese (oxides) in glass, effect of melting under reduced press., (9) 594.
Methane, the passing of king, (10) 693.
Microscopic examn. of the mineral constituents examn. of English china clays, (1) 5.
of the mineral constituents of some Amer. clays, (1) 3.
of whitings, (12) 903.
properties of silica-sand, quartz, chalcedony and French flint, influence of heat on, (10) 670.
study of ground coat and cover coat enamel reactions, (6) 322.
Mineral constituents of English China clays, microscopic examn. of, (1) 5.
of some Amer. clays, microscopic examn. of, (1) 3.
Molds for magnesite, chrome and silica brick, (2) 67.
Molecular formula, new type of, for glaze and enamel calcns., (6) 338.

North Dakota, Univ. of, ceram. work in, (3) 140.

Oil-fired fur. for the plant lab., (10) 713.
Opacity in white enamels, relation of fineness of grinding to, (12) 855.
Optical properties of quartz, tridymite, cristobalite, silica glass, raw and calcined flint and chalcedony, (9) 565.
Oxychloride stucco and flooring, new development in, (6) 311.

Permeability of clays to water, (12) 928.
Pig iron, sources of, effect upon the enameling of cast iron, (11) 806.
Plant control, the cost system as an aid to, (1) 43.
Plasticimeter, Emley, (6) 349.
Plasticity, mechanism of, from colloid standpoint, (8) 469.
of clay slips, measg. of, (6) 346, (12) 916.
Plastometer, Bingham, meas. of plasticity of clay slips by, (6) 350, (12) 916.
Porcelain, chipping resist. of, (3) 137.
compression strength of, (7) 390.
electrical, porosity of, (8) 532.
glaze, low fire, (1) 27.
glazes, maturing between cones 17 and 20, (7) 430.
high tension insulator, Beryl in, (5) 228.

talc as a flux for, (10) 675.
low fire, (1) 25.
manuf., economic handling of mat. in, (5) 235.
tensile strength of, (7) 385.
Porosimeter, for meas. of porosity by gas expansion, (2) 116.
Washburn-Bunting, McLeod-Gauge type of, (8) 527.
Porosity by method of gas expansion, (2) 112.
general method, (2) 113.
rapid method, (2) 116.
research (rapid) type, (2) 125.
Porosity by methods of absorption, (1) 48.
pycnometer method, (1) 53.
using vaseline, (1) 48.
Porosity meas. on full size brick, (8) 535.
of highly vitrified bodies, (8) 527.
Pots, glass, handling, storing and setting of, (3) 147.
Pressing terra cotta, (9) 623.
good and bad practice in, (9) 633.
Pulsichrometer method of applying glazes, (11) 826.
Pycnometer method for detg. porosity by absorption, (1) 53.

Quartz and cristobalite in silica brick, photomicrographic estn. of, (4) 207.
influence of heat on microscopic properties of, (10), 670.
phys. properties, thermal expansion and X-ray spectrum of, (9) 565.

Refractories, chrome and chromite, properties of and bibliography on, (12) 865.
for zinc smelting, (9) 597.
Refractory brick, effect of weather upon the strength of, (2) 107.
clays of Illinois, (10) 685.
clays of Texas, (9) 643.
heat insulators, need for more, (8) 554.
Research department of decorative ceram., organization of, (11) 758.
Resistance tests on fire brick under load at high temps., (4) 171.

Salts, sol., and clay wares, (8) 538.
Sand, influence of heat on microscopic properties of, (10) 670.
Scum on clay wares, (8) 538.
Shivering in terra cotta caused by finely divided silica, (8) 518.
elimination of, (8) 518.
Shrinkage meas., a convenient instrument for making, (1) 34.
Silica brick, comparison of hot and cold modulus of rupture of, (12) 888.
effect of weather upon the strength of, (2) 107.
influence of grind and burn on, (4) 165.
molds for, (2) 67.
photomicrographic estn. of quartz and cristobalite in, (4) 207.
suggested specifs. for, (4) 207.
testing of, (4) 209.
Silica glass, phys. properties and X-ray spectrum of, (9) 565.
Smelting, elec., of glass enamel, (5) 248.
Soda-lime glasses, disintegration of in water, (8) 504.
Solubility of glass in water, (12) 851.
Soluble salts and clay wares, (8) 538.
Sorrel cements, use of calcined dolomite in, (11) 817.
Stack, kiln, stability and design of, (7) 455.
Steel enamels, relation of compn. to thermal shock, (5) 263.
Steger load test app., (4) 209.
Stucco, dolomite-calcium chloride cements for, (6) 311.
dolomite magnesium chloride cements for, (6) 311.
oxychloride, new development in, (6) 311.
use of calcined dolomite in, (11) 820.

Table ware, comparative tests on Amer. and foreign, (6) 276.
Talc as a flux for high tension insulator porcelains, (10) 675.
Tank blocks, phys. defects in, (2) 102.
small glass, (3) 157.
Tensile strength of porcelain, (7) 385.
test specimens, control of glaze-fit by means of, (8) 500.
Terra cotta body, effect of some fluxes on the absorption and transverse strength, (11) 832.
casting, viscosity of Indiana clay slip with electrolyte for, (10) 702.
expts. on the firecracking of, (6) 299.
kilns, forced draft for, (7) 449.
pressing, (9) 623.
good and bad practice in, (9) 632.
problems suggested for discussion and investigation, (10) 732.
shivering of, (8) 518.
Texas, refrac. clays of, (9) 643.
Thermal expansion of quartz, tridymite, cristobalite, silica glass, raw and calcined flint and chalcedony, (9) 565.
Tile, hollow building, different methods of detg. absorption of, (11) 788.
Transmission of heat, with special ref. to the stoker fired boiler, (7) 420.
Transverse strength tests as a control of biscuit losses, (9) 588.
Tridymite, phys. properties, thermal expansion and X-ray spectrum of, (9) 565.
Tunnel kiln, continuous, at plant of A. C. Spark Plug Co., (6) 267.
Harrop, (8) 492.
railroad or continuous car, fuel conservation in the, (9) 602.

Ultra-microscopic examn. of whitings, (12) 903.
Underglaze colors, compns. of, for painting on biscuit, (6) 376.
liquid, compns. of for painting on biscuit, (6) 376.
Univ. of North Dakota, ceram. work at, (3) 140

Vapor lusters, glaze compns. taking good, (1) 28
Viscosimeter, MacMichael torsional, (6) 718
Viscosity of Indiana clay slip for casting terra cotta, (10) 702.
Volume, dry, of clay briquettes, (7) 394.

Washburn-Bunting porosimeters, by methods of absorption, (1) 48.
by methods of gas expansion, (2) 112.
Wastes, reduction of industrial, (7) 440.
Water smoking with induced draft, (10) 721.
Weathering effect upon the strength of refrac. brick, (2) 107.
of glass containers, (12) 837.
Wet process enamels for cast iron, (10) 647
White transparent glazes, compns. of, (6) 381
Whitings, comparative tests on English and domestic, (12) 901.
microscopic and ultra-microscopic examn of, (12) 903.

X-ray spectra of quartz, tridymite cristobalite, silica glass, raw and calcined flint and chalcedony, (9) 581.

Zinc oxide bodies, some properties of, (8) 488.
smelting, refractories for, (9) 597.

CERAMIC ABSTRACTS

Compiled by the

AMERICAN CERAMIC SOCIETY

ROSS C. PURDY, Editor
EMILY C. VAN SCHOICK, Ass't Editor

ABSTRACTORS: E. N. BUNTING, W. M. CLARK, L. H. COLE, JAMES L. CRAWFORD, R. R. DANIELSON, G. S. FULCHER, S. L. GALPIN, R. F. GELLER, JAMES HEPPLEWHITE, H. P. HOOD, R. M. HOWE, SHIJI KONDO, A. T. MALM, R. J. MONTGOMERY, LOUIS NAVIAS, C. W PARMELEE, C. M. SAEGER, JR., H. G. SCHURECHT, R. B. SOSMAN, H. F. STALEY, E. W. TILLOTSON, F. A. WHITAKER.

Vol. 1 December, 1922 No. 12

Author Index[1] to Abstracts for December

Author	Number of abstract
Adams, F. W.	133
Alexander, Jerome	46
Allen, W. H.	27
Anon	1, 2, 6, 12, 33, 34, 35, 39, 56, 58, 61, 64, 70, 74, 75, 80, 82, 91, 97, 99, 100, 102, 104, 123, 131, 135, 165, 166, 168, 169
Appleby, W. E.	14
Armstrong, Percival A. E.	114
Barkby, H.	10
Battegay, M., Hugel, G., and Voltz, Th.	143
Bean, Guy M.	110
Bellar, Chas. J.	184
Binkley, Kenneth L.	187
Bradshaw, L. and Emery, W.	62, 63
Bray, Chas. T.	109
Burgess, William	7
Bush, V. and Connell, L. H., Jr.	132
Byelvankin, D.	42
Byrnes, Clarence P.	153
Catlett, Chas.	172
Ceriat, Eugene	108
Chauvisé, J.	76
Clare, R. L.	8
Clark, Henry F.	159
Clark, Walter G.	150
Clarke, J. R.	125
Cox, Ora M. and Rose, Connie C.	161
Crowley, Joseph E. and Rowley, Clifford A.	147
Dalladay, A. J. and Twyman, F.	121
Didier, C.	164
Dimbleby, Violet, Hodkin, F. W. and Turner, W. E. S.	124
Doane, S. E.	19
Dochnal, Frank	116
Doerr, Carl F.	155, 156
Eardley-Wilmot, V. L.	60
Editorial	40, 81
Eisenbast, Arthur S. and Jordan, Walter J.	66
English, S. and Turner, W. E. S.	120, 127
Evans, John Edward	119
Evers, G. V.	134
Fairchild, C. O.	28
Farrant, J. C.	84
Fay, Chas. H.	186
Ferguson, L. A.	19
Fermor, L. L.	38, 71
Flagg, S. W.	17
Flight, W. S.	90
Funk, Samuel M.	117
Funk, W.	89
Gage, H. P.	138
Gault, H. and Boisselet, L.	29
Gelpke, Victor	21
Gerbel, Erich	93
Gillard, William	189
Good, Robert	148
Gunther	101
Haigh, T.	130
Hall, A. L.	32, 72
Hanlon, John H., and Wm. J.	157
Hannon, J. R.	18
Hardinge, Harlowe	9
Haslam, R. T.	16
Hatch, Arthur G.	188
Haws, William H.	115
Hayes, J. C.	15
Heller, H.	43, 95
Henker, Otto	144
Hering, Carl	19
Hess, H. W.	141
Hodkin, F. W. and Turner, W. E. S.	128
Houldsworth, H. S. and Cobb, J. W.	36
Hull, Walter A.	31, 98
Hutton, Edward S.	160
Jäger, G.	52
Kerner-Marilaun, F.	73
Kiddie, Frederick W.	185
Klein, A. A.	177
Krebs, W.	180
Kropf	178
Kühl, H.	179
Ladd, James B.	112
Lamme, B. G.	19
Langmuir, Irving	47
Lapp, G. W.	92
Lecher, Oskar	142
McCoy, J. P. A.	22
McDougall, Arthur	26
McDougal, Taine G.	23, 25
Macheleidt	48
Marckworth, Otto S.	145
Marlow, J. H.	5
Masson, Irvine, Gilbert, L. F. and Buckley, H.	122
Meyers, S. L.	175
Miles, Jno.	83
Milner, Edwin E. and Lytle, Wm. J.	154
Milton, Taliafero	19
Monasch, E.	45

[1] The abbreviation (*C. A.*) at the end of an abstract indicates that the abstract was secured from the Editor of *Chemical Abstracts* by coöperative agreement.

Author Index to Abstracts for December (*Continued*)

Author	Number of Abstract
Morey, G. W.	140
Moser, Theodor	191
Mott, William Roy	67
Mulholland, Vergil	146
Nathanson, J. B.	139
Neese, Otis V., Flo L. and Earl C.	118
Ogden, Ellsworth P.	24
Parmelee, C. W.	87
Parmelee, C. W. and Schroyer, C. R.	65
Patch, Wm. E.	163
Peddle, C. J.	129
Perry, Allen M.	13
Pieters, I. S.	59
Pilkington, Alfred and Gaskill, Joseph	152
Potter, Stephen J.	190
Pritchard, G. A.	86
Rebuffat, Orazio	68
Rees, W. J.	136
Ri	57
Riche, R. and Poetsch, Ing. W.	78
Richey, William F.	111
Rieke, R.	55
Ritchie, H. C.	167
Ryther, Henry A.	151
S.	103
Said, Jesse M.	158
St. Austell	37
Sandstrom, C. O.	173
Schumacher, Earle E.	182
Scohy, John B.	149
Scott, Alexander	51
Scott, W. S.	20
Sexton, A. Humboldt	69
Sharkey, Samuel M.	41
Shively, R. R.	137
Sinnatt, F. S. and Craven, M. B.	54
Smith, E. W.	3
Smith, Herbert M.	162
Spackman, H. S.	170
Steger, W.	11, 77, 79, 88
Stott, Verney	30
Stradling, R. E.	176
Sullivan, Chas. L. and Fletcher, John D.	106
Thomas, C. W.	3
Torchio, Philip	19
Toupet, Julius H.	113
Travers, M. W.	3, 126
Trillich, H.	94, 95
Trullinger, Daniel N. and Granger, Leo A.	183
Tschermak, G.	49
Tyrrell, G. W.	50
U. S. Bureau of Standards	96, 181
Van Zandt, P. C.	174
Warner, Geo. A.	107
Washburn, E. W.	44
Watts, Arthur S.	85
Weber, Bernard F.	105
Whitlock, E. H. and Burgoon, C. E.	171
Woolf, Percival J.	4
Zsigmondy, Richard	53

General and Miscellaneous

1. Continuous kilns for pottery manufacture. ANON. *Brick Pot. Trade Jour.*, **30,** 205(1922).—The employment of continuous kilns for firing pottery has in some cases failed because the potters insist on burning colors in them—which is only practical in single ovens. Continuous kilns of the Hoffmann type have not been used to any great extent for domestic pottery, but have proved satisfactory for sanitary ware. There is no reason why they should not be used for whiteware. Tunnel ovens or car-kilns are suitable for whiteware but can only be used for a limited number of colors. The initial cost would be prohibitive for works with a small output but remunerative for a sufficiently large plant. The tunnel kiln can be filled more efficiently, which saving together with a reduction of cost of saggers and fuel favors this type of kiln. The tunnel oven has a small variation in output and in this respect is inferior to the continuous compartment kiln which can if the need arises be worked as a series of separate compartments. H. G. SCHURECHT

2. The business situation and outlook. ANON. *N. J. Ceramist,* **1** [2], 97–108 (1921).—A symposium of views of various business men regarding the business outlook, with particular reference to the clay products industry. C. W. PARMELEE

3. Symposium on gas firing. II. E. W. SMITH. *Trans. Ceram. Soc.* (Eng.), **21,** 189–207(1922).—In the Dayton system of vaporizing oil used in the U. S., four gallons of fuel oil give 1000 cu. ft. of gas having a calorific value of 450 B. t. u. M. W. TRAVERS. —In an investigation of direct fired coal furnace by the U. S. Bureau of Mines, it was shown that in every case the whole of the oxygen had disappeared before it had risen four inches from the fire bars, and that in every case the gas which came from the top was what might be called a fair producer gas. Every so-called direct-fired commercial furnace is actually a gas producer, in which the gas is sometimes burned by secondary

air, but very often is not burned. We should discard the word "direct-fired" and regard all coal fires as producer systems, in which the fuel is more or less efficiently gasified, and in which, above the fuel bed, the gases are more or less efficiently burned. Producer gas can be burned with cold secondary air. Preheating the air usually furnishes the only method of getting it into the furnace. When the furnaces are not furnished with recuperators, the air can be injected by means of a fan. The total efficiency of the recuperative furnaces is much higher than that of the non-recuperative furnaces, but the difference has nothing to do with the difficulty of burning the gas with cold air, for no difficulty has been experienced. The fact that furnace builders regarded the problem of introducing secondary air into furnaces as one involving statics rather than dynamics has been the cause of failure of many furnaces. One has not merely to consider whether air would flow through the channels in a certain direction, but whether the rate of flow will be sufficient to provide for the complete combustion of the gas. Lt.-Col. C. W. Thomas.—Whatever economies there are in gas firing will be found to result not from a mere change over in system from using solid fuel in a fire hole to gas from a producer, but the problem will resolve itself into a question as to whether or not recuperation is used in heating. In a continuous kiln, whatever may be the type of firing, recuperation always is employed. Attention should be given to the insulation of kilns. H. F. S.

4. Combustion of fuel oil; with a description of an oil-gas furnace. Percival J. Woolf. *Trans. Ceram. Soc.* (Eng.), **21,** 161–88(1922).—Experiments carried out with some fuel-oils indicate that below 200°C, the quantity that is vaporized is negligible, and that between 200°C and 300°C, only a small portion of the fuel-oil can be vaporized. When raised to a temp. of over 300°C the fuel-oil commences to vaporize more extensively, and when 400°C is reached it is substantially vaporized. At 450°C it has been found that it is completely vaporized except for a minute quantity of solid, this quantity being under 1%. To eliminate the excess air in burning oil, and at the same time obtain perfect combustion within the furnace proper, without increasing the size of the furnace or adding to it in the way of combustion chambers, the vaporization and mixing of the oil and air, prior to the entrance into the furnace, has been accomplished according to Woolf by the Sklovsky U. S. Patent No. 1,229,338. In this case the air is supplied under pressure, is forced through heating chambers which utilize the heat from the incoming gases, and is further forced from the heating chambers through a vaporizing chamber. Through the inlet the necessary fuel oil is supplied into the latter chamber, the oil being introduced into a stream of heated air; it passes through the vaporizer, together with the air, from which it absorbs the heat. By the time the exit of the vaporizer is reached the oil is completely vaporized and intimately mixed with the air, from which point it is conducted through a tube directly into the combustion chamber of the furnace. In this patent the air is maintained at not less than 300° and not over 400°C. Preferably the air should be 350 to 400°C. A description is given of the car tunnel kiln built at the plant of the Lennox Pottery Co., in Trenton, N. J., and arranged for firing with vaporized oil. It is a twin chamber furnace in which the stock progresses through the two chambers in opposite directions. The treating zone is near the center; thus a single source of heat supplies both chambers, and the entering cold stock is preheated by the treated stock enroute to the exit. The efficiency of this heat transfer is dependent upon the natural convection currents set up in the inert atmosphere of the furnace by the heat radiated by the charge. H. F. S.

5. The Marlow gas-fired tunnel oven. J. H. Marlow. *Trans. Ceram. Soc.* (Eng.), **21,** 153–60(1922).—A detailed description with drawings of a car tunnel oven fired with producer gas. The air for combustion passes in flues from the receiving end of the kiln through the firing zone and then to the burners. H. F. S.

6. The new ceramic station at Rutgers College, State University of New Jersey. ANON. *N. J. Ceramist*, **1** [2], 109–12(1921).—A brief statement regarding the plans for the erection of a building. C. W. PARMELEE

7. Tariff revision and regulation. WILLIAM BURGESS. *N. J. Ceramist*, **1**, 80–7, June(1921).—A discussion of the revision of the tariff with special reference to clay products. C. W. PARMELEE

8. Oil burning in a ceramic plant. R. L. CLARE. *N. J. Ceramist*, **1** [2], 126–30 (1921).—The author discusses oil burning under the following headings: The adaptation of fire box; the equipment required; comparison of relative costs of oil and coal. He finds that 150 gals. of oil will do the same work as a ton of coal in kiln practice, and better than that. At 5c. a gal. the relative cost of oil is $7.50, coal cost $6.00. He is of the opinion that this cost can be reduced by careful firing. The higher cost of oil is offset in a large degree by the fact that with oil there is a reduction in the amount of kiln labor necessary, also neither coal nor ashes have to be handled. C. W. P.

9. The Hardinge conical mill in the ceramic industry. HARLOWE HARDINGE. *N. J. Ceramist*, **1** [2], 137–44(1921).—There are two types, the conical ball mill and the conical pebble mill. The ball mill is used either for wet or dry grinding, and usually where the feed is comparatively coarse, that is, up to 2″, and where a slight iron contamination of approx. .05% will not be detrimental to the product. The pebble mill is used principally where this contamination is objectionable. By the use of the conical shape there is a segregating effect which occurs within the mill which permits of the use of a coarse feed, and the delivery of a fine product in one unit, and at the same time maintaining a high capacity for the power consumption. This shape also enables the mill to withstand shock and prevents undue wear of the lining. Also, the mill is extremely rigid in construction. *Feldspar grinding.*—A typical installation is a conical pebble mill 5 ft. in diameter. When operated in conjunction with a vibrating screen, for obtaining a fine product, the mill is capable of delivering a finished product in one operation. The product is approx. 90% through 100-mesh. An 8′ 30″ conical pebble mill requires 40 to 50 h. p. to operate, and has a capacity on ordinary feldspar grinding to 90% through 100-mesh, of 2½ T. per hour, the repair costs averaging below 4 c. per ton over a period of 8 yrs. For the finer grinding of feldspar, that is, for a fineness of less than 1% on 140-mesh or 98% through 200-mesh, it has been found best to use two mills. The use of an air separator in conjunction with this mill not only gives a product of the proper fineness, but actually aids the operation of the mill. *Silica grinding.*—A 6′ by 48″ Hardinge pebble mill, requires approx. 30 h. p. operating in conjunction with an air separator, has a capacity of 1 T. per hr. the feed being 3/4″ and the product 90% passing a 200-mesh screen. The mill grinds with a minimum of fineness and when sharp corners must be retained on the particles discharged. C. W. P.

10. Description of a tunnel kiln in Czecho-Slovakia. H. BARKBY. *Trans. Ceram. Soc.* (Eng.), **21**, 277–88(1922).—This is a Faugeron kiln firing porcelain to cone 14. The compn. of the body is: China clay, 40; flint, 30; feldspar, 30. The glaze is composed of the body mixt. plus lime, part of the china clay being first calcined. The clay ware is fired first to about 950°C in a tunnel kiln similar to the one described, after which it is dipped and both body and glaze matured at cone 14. The total length of the oven is 60 m. (196 ft.), with a fireplace on either side at the middle. The width of the inside is about 1.25 m. (4 ft.), and the length from the rails to the vault roughly 3 m. (10 ft.). Below the level of the rails is an inspection passage large enough for a man to walk down. It is almost the full length of the tunnel, with entrances at several convenient points to enable the attendants to pass from one side to the other without having to walk around the tunnel. At the entrance to the tunnel is situated the motor which drives the fan for drawing gases to the chimney and also which pushes the trucks

through. On the exit side of the fireplaces are 2 secondary air channels which conduct the heated air from the cooling goods to the fireplaces. The trucks measure 2 m. (6.5 ft.) long by 1.25 m. (4 ft.) wide. Immediately above the wheels is a platform made by strong sheets of iron with the sides turned down for a couple or 3 in. These iron lips are for the purpose of the sand seal. On this iron platform is built a solid bed of fire-clay bricks approx. 9 in. thick, to protect the iron and to insulate the oven. A groove runs along each side of this brickwork and into this fits a rib which runs the whole length of the tunnel. Above this solid bed of fire-clay bricks are arranged fire-clay studs similar in shape to a cotton bobbin, only much larger, being about 10 in. high. When these studs are placed side by side flues are formed both lengthways and crossways of the truck with gaps in the upper surface. The studs on either side are a little different in shape on the upper surface, so as to give a fairly straight edge to the truck. On this layer of studs are placed the saggars, containing the ware to be fired, to a height of 2 m. (6.5 ft.) and then above and across them are put fire-clay baffles. This completes the loading of the truck, but before it is sent into the tunnel it is passed under a loading gauge similar to those used on the railway to see if it is over or under loaded. Although air locks are provided at the entrance and exit, they were not being used. The saggars and fire-clay baffles fit so close to the walls and roof of the tunnel that they are not needed. The gases, on leaving the tunnel, are at a temperature not higher than 300 to 350°C and are used for heating a greenware house and storerooms before going into the chimney. The goods as they leave the tunnel are cool enough to handle. The saggars are thinner than those in common use here and are machine made. The underneath surface of the saggar is concave, which it is claimed, gives strength with lightness. The tunnel holds 30 trucks, and a truck travels from one end to the other in 36 hrs. In 24 hrs. the output is almost equal to one 18-ft. round oven. The coal consumption per day is about $2^1/_2$ to 3 T. of local brown coal. As they are firing porcelain, it is necessary to have a reducing atmosphere, and they "smoke" for $^2/_3$ of the distance from the fireplaces to the entrance. Repairs are very small. Only once a year is it necessary to attend to the fire boxes. The under carriages which were put into use 12 to 16 yrs. ago are still running without having been repaired. The following kilns are in use on the Continent: For earthenware industry 9 kilns; for porcelain 7 kilns, with 3 being built; for firebricks 2 kilns; for wall tiles 1 kiln, with 1 being built. In the discussion, doubt was expressed by several potters as to whether the drop arches and clay baffles produced an up-and-down flame of gases in the Faugeron kiln. H. F. S.

11. Surface combustion and the possibility of its adaptation to the ceramic industry. W. STEGER. *Trans. Ger. Ceram. Soc.*, **2,** 83(1921).—Surface combustion will probably find application first for heating muffle or tunnel kilns. The burning of limestone, dolomite, magnesite, etc. can be carried on economically by this method as high temperatures can be reached with a comparatively poor gas seeing that combustion takes place in the restricted space between the fragments of the charge. The suggestion is made that this firing method would find successful application in the burning of the Dressler tunnel kiln if the hollow interior lining of the fire zone were filled with suitable refractory fragments and the gas was drawn through this mass under a slight vacuum. The research laboratory of the State Porcelain Works, Berlin, has installed several miniature kilns of this type for further study. F. WHITAKER

12. Soap making possibilities in china-clay. ANON. *The London Times Trade Supplement*, **101,** 457(Aug. 19, 1922).—Expts. have been proceeding for some time which have for their object the developing from china-clay, a colloidal clay as an integral part of soap. As it supersedes the fats and oils usually employed in the making of soap, it is claimed that it will produce a cheaper soap and create a new demand for china-clay. The expts. also show that it is possible to make a colloidal clay soap directly from either

(1) an oil or fat or (2) a mixt. of fatty acids, the soap produced having similar properties to that made by incorporating the colloidal clay after the soap has been made. The greatest value of the direct method of prepg. a colloidal clay soap lies in the saving of time required for saponification. Other advantages over ordinary soap that colloidal clay soap is said to possess are: (1) It is more sol. in water and produces a lather quicker. (2) It is ready for use sooner after manuf. than ordinary soap and dries quickly; does not become too dry by long keeping. (3) It is less likely to contain free fatty acids or free alkali; the quantities of reacting material can be more easily adjusted, and any slight excess of alkali is counteracted by the absorbent power of the colloidal clay. (4) It improves greatly in quality on aging, whereas soap alone generally deteriorates after 18 mo. or so. Mr. F. E. Weston, one of several industrial chemists who have been carrying out expts. states that it cannot be maintained that colloidal clay is only playing the part of a "filler;" it is more in harmony with exptl. fact to term it "an active principal." The china-clay producers are alive to the possibilities of this new outlet for china-clay, and some of them are either producing colloidal clay or are prepg. to do so. O. P. R. O.

13. Fuel economy and production expenses. ALLEN M. PERRY. *Elec. World*, **80**, 115–8(1922).—Data are given for elec. plants burning coal, oil, gas and hogged fuel. Careful analysis of data permits interesting comparisons between the results obtained. Today some of the plants are getting back to a net station cost of about $0.01 per kw.-hr. C. G. F. (*C. A.*)

14. The practical economization of coal fuel and the responsibility for it. W. E. APPLEBY. *Commonwealth Eng.*, **9**, 396–404(1922).—A discussion of the principles of fuel saving in boiler plants, presenting charts and formulas for computing losses from CO_2 recorder readings, and the saving effected by economizers. E. W. THIELE (*C. A.*)

15. Waste-heat boilers in steel plants. J. C. HAYES. *Blast Furnace and Steel Plant*, **10**, 355–6(1922).—The installation of waste-heat boilers in steel plants is becoming more and more important. In most modern plants the boilers are either being placed or space is left for their later installation. A boiler for this purpose is differently arranged from the firing type, because ordinarily the larger part of the heat transmitted into the boiler water is from radiation; this is usually absent in waste gases. The boiler must, therefore, be arranged so that the gases have greater contact with the boiler surfaces in order to prevent the stagnant film of gas from being present. An ordinary 75-ton open-hearth furnace is capable of yielding power equal to 350 boiler h. p. per hr. in steam of 160 lbs. pressure and 100° superheat. W. A. MUELLER (*C. A.*)

16. Keeping down the furnace losses. R. T. HASLAM. *Power*, **55**, 372–5(1922).—A certain amt. of excess air is necessary for most economical operation of a boiler. Charts are shown wherefrom the correct amt. of excess air may be calcd. after analyzing the flue gases with an Orsat app. and detg. the stack temp. D. B. DILL (*C. A.*)

17. Low ash coal not always desirable. S. W. FLAGG. *Power*, **55**, 328–30(1922).—A high-grade coal with 4.30% ash gave considerable trouble when used in an automatic stoker. The tops of the grate bars reached a dark red to cherry-red temp. and serious damage to the bars resulted. Expt. proved that the lack of ash in the coal prevented the formation of a heat-insulating layer of ash over the bars. The substitution of a high-ash coal solved the problem. D. B. DILL (*C. A.*)

18. The economical production and use of steam. J. R. HANNAN. *J. Textile Inst.*, **13**, 95–100(1922).—A comparison of the coal-fired and the oil-fired boiler. An argument is advanced in favor of a condensing unit in a plant which uses process steam. L. A. P. (*C. A.*)

19. Some suggestions concerning the college education of an engineer. CARL HERING. *J. Am. Inst. Elec. Eng.*, **41**, 415–7(1922). B. G. LAMME. *Ibid.*, 406–9.

S. E. DOANE. *Ibid.*, 409–11. PHILIP TORCHIO. *Ibid.*, 412–3. TALIAFERO MILTON. *Ibid.*, 606–9. L. A. FERGUSON. *Ibid.*, 570–1. C. G. F. (*C. A.*)

20. Industrial electric heating. W. S. SCOTT. *Elec. J.*, **19**, 203–8(1922).—Modern elec. furnaces and ovens for annealing, hardening, tempering, drying, baking, enameling, glass and ceramics are briefly considered. In the appendix 21 examples of various heating processes are cited with detailed operating data. C. G. F. (*C. A.*)

PATENTS

21. Kiln with heating chambers and cooling chambers. VICTOR GELPKE. Luzern, Switzerland. 1,426,287, Aug. 15, 1922. A kiln, comprising, in combination, a furnace, a heating-chamber, a cooling chamber, and a compensating-member arranged between the chambers; the member consisting of two sheet-metal plates arranged at an appropriate distance one from the other, and gas-tight connections between the plates, as well as between them and the structure-components with which they are connected. C. M. S., JR.

22. Plastic composition and articles formed therefrom. JAMES P. A. MCCOY. U. S. 1,425,784, Aug. 8, 1922. An insulating compn. comprising bakelite mixed with a polymerizable resin. C. M. S., JR.

23. Burning ceramic wares and apparatus therefor. TAINE G. MCDOUGAL. U. S. 1,416,726, May 23, 1922. That improvement in the art of burning ceramic wares which consists in continuously passing the wares through a kiln having a preheating zone, a high-temperature zone and a cooling zone, and maintaining the wares openly exposed to radiation from the under surface of the ceiling of the kiln in the high-temperature zone for a period sufficient to insure thorough burning throughout the whole mass of the wares, the under surface being intensely heated by combustion in the space between it and the wares. C. M. S., JR.

24. Tunnel kiln. ELLSWORTH P. OGDEN. U. S. 1,418,669, June 6, 1922. A tunnel kiln provided with a main stack or fan and also having an auxiliary stack or fan independent thereof by which special bases and vapors which have been introduced into the kiln for special purposes may be removed therefrom without resort being had to the means for inducing the main draft. C. M. S., JR.

25. Burning ceramic wares. TAINE G. MCDOUGAL. U. S. 1,416,727, May 23, 1922. In a continuous kiln for burning ceramic wares, a thin highly refractory carrier forming the support for the wares, supporting means on which the carrier travels through the kiln, the space about the supporting means being filled in with heat insulating material to a level close up to the lower side of the carrier, the supporting means including a highly refractory element projecting through the floor of the kiln on which the carrier directly rests and with reference to which the carrier is movable. C. M. S., JR.

26. Gas-fired pottery kiln. ARTHUR MCDOUGALL. London. 1,423,408, July 18, 1922. A gas-fired rectangular kiln for burning argillaceous ware, a gas bag therein constructed independently of the brickwork of the kiln, the gas bag dividing the kiln into a plurality of compartments, the bag having constricted apertures in the sides and top whereby heating gases escaping from the bag are evenly distributed and traverse the ware contained in the kiln between the bag and the walls of the kiln, the bulk of the gas passing through the ware in a horizontal direction. C. M. S., JR.

27. Weatherproofing clay. W. H. ALLEN. U. S. 1,421,888, July 4. The capillarity of the surface of an unbaked clay article is destroyed by pptg. Ca silicate in its interstices. (*C. A.*)

Apparatus and Instruments

28. Disappearing filament optical pyrometer free from diffraction effects at the filament. C. O. FAIRCHILD. *Phys. Rev.*, **18**, 116–8(1921); *Science Abstracts*, **23A**, 224. H. G. (*C. A.*)

29. The use of commercial viscosimeters. H. GAULT AND L. BOISSELET. *Mat. grasses*, **14**, 6185(1922).—In a particular instance an Engler-type viscosimeter gave a viscosity at 50° for a machine oil 1° Engler lower than a standard instrument. This was traced to the fact that the capacity of the chamber in the first instrument was 8 cc. too great, causing an increase in head. This did not appreciably affect the rate of flow of water at the temp. of standardization, but increased that of the oil at 50°.

A. P.-C. (*C. A.*)

30. Note on pipettes. VERNEY STOTT. *J. Soc. Glass Tech.*, **20**, 307–25(1921).—A collection of data on the variation of the volume delivered by pipettes of capacity 2 to 100 cc. with the delivery and drainage time. Class A pipettes should be adjusted for a particular delivery time which should lie between certain limits, depending on the capacity, and a definite time should be allowed for drainage when graduating, testing, or using them.

G. S. FULCHER

31. Pyrometer possibilities. WALTER A. HULL. *N. J. Ceramist*, **1** [2], 113–6 (1921).—Brief article outlining the function of pyrometers and their value as a permanent investment.

C. W. PARMELEE

Chemistry, Physics and Geology

32. Asbestos in the Union of South Africa. A. L. HALL. *Union of S. A. Dept. of Mines and Industries, Memoir*, **12**(1918).—The Union of S. Africa contains large asbestos deposits and holds the world's record for varieties of fibre. In areal extent the crocidolite belt of the Cape Province is the largest asbestos area of any kind hitherto recorded. The fibre varieties comprise the following, named in order of abundance: (1) *crocidolite*, (2) *amosite*, (3) *chrysotile*, (4) *tremolite*. These varieties are distributed thus: (1) the Cape, crocidolite, (2) the Transvaal, crocidolite, amosite, tremolite, and chrysotile, (3) in Natal, chrysotile and tremolite. The Free State has not so far furnished any asbestos deposits. Crocidolite or "Cape blue" is the best-known variety in the Union; its occurrences having been exploited without interruption since 1892. The crocidolite belt in the Cape measures some 250 mi. in length, with a max. width of over 30 mi.; this distribution consists of a great thickness on thinly-bedded ferruginous siliceous slates or banded ironstone, to which the crocidolite is confined in the form of many strictly interbedded cross-fibre seams, ranging from the max. of 5″ downwards; most of the seams consist of lavender blue fibre from $^1/_4$″ to 1″ in length. In the Transvaal crocidolite interbedded cross-fibre seams occur in the basal portion of the Pretoria Series close to the underlying dolomite, in ferruginous siliceous slates practically indistinguishable from banded ironstones, and consist of the same lavender-blue fibre as in the Cape belt. Their exploitation is still in the initial stages. Amosite has so far been found in the Transvaal only. It forms a new variety of asbestos as a monoclinic ferrous silicate amphibole with or without soda. Amosite is an ash-gray or pale brownish mineral, occurring as interbedded cross-fibre seams in the same banded ironstones of the basal portion of the Pretoria Series (close to the underlying dolomite) in which crocidolite is found. The length ranges from the not uncommon value of 11″ downwards; very frequently from 4″ to 7″ wide over considerable distance. Chrysotile forms a commercial occurrence in the Transvaal only. This asbestos forms cross-fibre seams interbedded in altered dolomite and ranging from the very rare maximum of 7″ downwards. Seams of $^1/_2$″ in thickness are common. The Natal chrysotile is found in cross-fibre seams in dark greenish serpentine and disposed vertically along and very close to the contact with an aplite intrusion. These deposits appear closely analagous to the Canadian type of deposit. The present economic situation makes the establishment of local mfg. industry of asbestos goods very welcome. Such factories exist, in which crocidolite, amosite, or tremolite (with its country rock of talc) are

adapted to various uses; among these, the requirements of the building material and engineering trades claim first attention, *e. g.*, roofing tiles, flooring, coiler lagging, etc. The suitability of Cape blue for the manuf. of goods requiring spun fibre has long been well established, and recent expts. carried out under proper technical conditions have demonstrated that amosite can also be fiberized and adapted for yarn production. This memoir contains analyses of asbestos, a bibliography on the subject; also maps and plates. O. P. R. O.

33. Neutral salt. ANON. *Raw Materials Rev.* (London), **1,** 167(1922).—With the development of the production of synthetic ammonium sulphate, it is reported that sulphate fertilizer, which has always contained an excess of acid, is now giving way to the neutral ammonium sulphate. It is predicted that within the next 2 yrs. it will have become impossible to sell the acid-contg. product. There are many processes whereby acid-contg. ammonium sulphate may be converted into the neutral product, or whereby the natural product can be made directly. These processes may be classified as follows: (1) Washing or spraying processes: (*a*) With atomized water; (*b*) with treated mother liquor; (*c*) with weak solns. of ammonia obtained in various ways. (2) Treatment with gaseous ammonia under a moderate pressure. (3) Incorporating a neutralizing agent in solid form. (4) Production of neutral ammonium sulphate within the saturator or saturators. The production of the neutral salt entails careful chem. control, and the process requires supervision by trained men. At the present time the importance of this new development in the sulphate industry is, perhaps, of moment to the English fertilizer industry only. It is believed, however, that before long its significance will apply to other countries as well, for it is contended that the neutral ammonium sulphate is more effective as a fertilizer than the acid salt. O. P. R. O.

34. Rhodesia asbestos. ANON. *Raw Materials Rev.* (London), **1,** 143(1922).—The 1921 output of Rhodesia asbestos was valued at £795,699, as against £5,224 in 1913. It should be noted that Rhodesia is second only to Canada in the production of asbestos. O. P. R. O.

35. Fluorspar in Prussia. ANON. *Raw Materials Rev.* (London), **1,** 155(1922).—Fluorspar, or calcium fluoride, is the only material which is used in Prussia for the production of hydrofluoric acid. It is used also in certain metallurgical processes, such as in the smelting of roasted copper ore, and, as long as it remains cheap enough, in the iron works. Colorless fluorspar has also been used for optical purposes. Fluorspar is found only in gangue, and therefore is frequently with iron. The occurrence of fluorspar in Germany is very frequent, although mostly in small volume. It is produced at Uftrugen, and in the Claustaal. O. P. R. O.

36. The reversible thermal expansion of silica. H. S. HOULDSWORTH AND J. W. COBB. *Trans. Ceram. Soc.* (Eng.), **21,** 227–76(1922).—The reversible linear expansions of various forms of silica, raw and manufd. were detd., and along with them permanent changes in sp. gr. and refractive index. Pure amorphous pptd. silica underwent no change at 700°C even on prolonged heating, but after heating at 1170°C or cone 14, showed the great expansion between 200 and 300°C, characteristic of cristobalite (with a little tridymite). Pptd. silica contg. 5% soda showed the cristobalite expansion between 200 and 300°C after heating at 700°C, but heating at 1170°C, or at cone 14 gave the smaller (tridymite) expansion between 100 and 170°C and some cristobalite. The presence of the soda was apparently responsible for the formation of cristobalite at a lower temp., and for the formation of tridymite. Silica glass (vitreosil) gave very little thermal expansion but the refractive index corresponded with the formation of tridymite, to a small extent at cone 14 and to a considerable extent at cone 20. Quartz was not formed from amorphous silica in any of the above expts. Meanwood ganister with lime bond showed no cristobalite after a works burn to cone 9 but a little

cristobalite along with quartz after a lab. burn to cone 14, and more cristobalite at cone 19. Repeated works firing at cone 9, however, gave a little cristobalite even without bond. Welsh quartzite with lime bond transformed more easily. It gave a little cristobalite in the quartz at cone 9 (works burn), more at cone 14, and all cristobalite at cone 20. Flint with lime bond transformed more easily still. It gave some cristobalite at cone 9, nearly all at cone 14, and all at cone 20. None of these raw materials gave tridymite in any quantity. All of them underwent a considerable permanent linear expansion in the lower temp. ranges before any conversion of quartz occurred. The true sp. gr. and refractive index were not altered thereby but the porosity increased. The amount of the change differed in the three materials. (*a*) From Welsh quartzite, fired at cone 16. This brick showed the large cristobalite expansion between 200 and 300°C, and also some quartz expansion between 500 and 600°C. (*b*) From Yorkshire quartzitic pebbles. This brick showed the α to β cristobalite expansion, but no α to β quartz expansion between 500 and 600°C. A little tridymite may have been present. Silica bricks (from Welsh quartzite) after long use. (*a*) In coke oven (maximum temperature 1450°C). The innermost exposed layer was an impure glass with a steady expansion but only half as large between 15 and 1000°C as that of the layers behind, which will make for shelling away. The rest of the brick was all cristobalite with very little quartz or tridymite. Examn. of commercial silica bricks and used bricks from coke ovens and steel furnace roofs showed that the exposure to high temp. had evidently completed the change from quartz to cristobalite which had been largely effected in the kiln during manuf. Little or no tridymite was found. The vol. changes in manuf. and use of a silica brick may therefore be traced thus: First, on burning, the quartz undergoes a permanent linear expansion, with little or no decrease in specific gravity but an increase in porosity. This permanent expansion may be about one-half per cent even below 1000°C and considerably more at cone 9. The toughness may appreciably alter in consequence. The further burning to cone 14–16 alters the expansion curve, changing the quartz completely or partially, according to the nature of the raw material and the time and temp. of burning, into cristobalite. This means that the sudden α- to β-quartz expansion between 500 and 600°C is replaced by the α- to β-cristobalite expansion between 200 and 300°C. The total reversible expansion is not lessened. The furnace of "cristobalite" bricks is therefore much less subject to expansion strain at dull redness than one of "quartz" bricks, although more so below 300°C. Neither is at all sensitive above 600°C. Long exposure in use at high temp. completes the conversion of quartz to cristobalite. Apart from actual test in the expansion apparatus, the authors have found that a detn. of the true sp. gr. of the powdered brick is the best guide to its behavior as regards expansion and contraction. In the discussion it was claimed (by Arthur Acton) that the detn. of the true sp. gr. of the powdered brick is a guide to the possible vol. changes in the brick during its use, but only in so far as bricks of about the same lime content are being compared. Comparison of powder densities of bricks with 1.5, 2.0, 3.0 and 5.0% of lime indicate that with high lime content powder densities as low as 2.30 are compatible with the presence of unchanged quartz. H. F. S.

37. China clay. ST. AUSTELL. *Quarry & Surv. & Contractors' Jour.*, **27**, 290 (1922).—The lessening of dependence upon manual labor is discussed. Before the war a few works had introduced hydraulic hoses for washing the clay, it being found that the enormous pressure of water obtainable by this method was sufficient to wash the clay without the aid of men to break it up first. Various methods of removing overburden, and shaft and tunnel working. No new methods described. O. P. R. O.

38. Clay in India. L. L. FERMOR. *Geol. Surv. of India: Records*, **53**, 256(1922).—In Rajmahal hills there are valuable deposits both of china-clay and of fire clay. The

china-clay occurs in 3 ways, *viz.*, (*a*) as the decompn. product of feldspar in the fundamental gneisses and schists; (*b*) in the white Damuda sandstone, where its presence is due to the decomposition of feldspar originally present in the sandstone, and (*c*) as beds of white china-clay interbedded with white Damuda sandstone. The principal bed of kaolin of the first mode of occurrence is 40–100 ft. thick. In the second mode of occurrence the china-clay is extracted from the sandstone by crushing, washing and settling; the china-clays of the second and third occurrence are used by the Calcutta Pottery Works. In addition, fire clays are found in beds ranging from 1 to 15 ft. thick in numerous localities in coal fields. O. P. R. O.

39. Kaolin deposits in Finland. ANON. *Jour. Royal Soc. Arts*, **70**, 526(1922).—Investigations concerning the extent of kaolin deposits in Finland show very favorable results. The deposits are 4 to 6 m. deep; in some places the stratification is over 10 m. deep, and it has been noticed that the deeper stratification furnished the better kaolin. According to German experts, this kaolin is of excellent quality, clearer and better than elsewhere in Europe; and the china made from it is entirely white. O. P. R. O.

40. Ferro-silicon from feldspar. EDITORIAL. *Iron & Steel of Canada*, **5**, 154 (1922).—Potash of feldspar has been made available for human use in Sweden. Most of the processes have failed because they aimed at the recovery of the potash in the mineral, which is at best but 13 or 14% of its bulk. A commercially pure potash feldspar will contain 65% silica, 18% alumina and 13% potash, the remainder being mainly soda. J. E. Johnson, Jr., in 1920 applied for U. S. patents that described the manuf. in the elec. furnace of ferro-silicon from potash feldspar and scrap iron, the potash to be volatilized by the extreme temp. of the furnace and the fume caught and condensed. The Swedish process is similar, but simpler. Ferro-silicon is made from the same ingredients, but the potash is not volatilized and remains in the slag in combination with the alumina and other slag-making ingredients of the charge. This slag, from which the potash is readily dissolved, is ground and applied directly to the fields as fertilizer, presenting an excellent opportunity to Canadian manuf. of ferro-silicon. The large bodies of potash feldspar readily accessible and the cheap hydro-elec. power available for manuf. would point the way for one more Canadian industry. O. P. R. O.

41. The clays of Mercer County. SAMUEL M. SHARKEY. *N. J. Ceramist*, **1** [2], 131–6(1921).—A brief description of the important clay areas in New Jersey, with particular reference to Mercer County deposits and their uses. C. W. PARMELEE

42. Specific gravity and refraction of the potash-soda-feldspars. D. BYELVANKIN. *Bull. Petrograd Polytech. Inst.*, **24**, 437–52(1915); *Mineralog. Abstracts*, **1**, 89–90.—Analyses of K-Na feldspars from the literature showed no relations between compn., sp. gr.,

	I	II	III	IV
SiO_2	64.00	65.33	63.67	66.46
Al_2O_3	19.25	18.82	19.60	18.89
Fe_2O_3	....	....	....	0.75
BaO	0.41	....	0.98	....
CaO	0.15	0.39	0.40	0.61
Na_2O	1.86	4.23	3.62	7.68
K_2O	14.01	10.20	11.16	5.17
Ign.	0.50	0.78	0.33	0.69
Sum	100.18%	99.75%	99.76%	100.25%
Sp. gr.	2.570	2.582	2.595	2.606
α	1.5191	1.5219	1.5223	1.5255
β	1.5228	1.5257	1.5260	1.531
γ	1.5249	1.5275	1.5283	1.532

and n_D. New detns. were made, and the sp. gr. and n, calcd. for the K-Na portion when plotted against $Ab\%$, fall in a straight line. The results are shown on preceding page. (I) adularia, St. Gothard; (II) orthoclase, Ceylon; (III) microcline-microperthite, Savelev ravine, Ilmen Mts.; (IV) anorthoclase, Berkum, Rhine. E. F. H. (*C. A.*)

43. Modified method for the detection of tin. H. HELLER. *Z. anal. Chem.*, **57**, 180–2(1922).—Treat 1 cc. of the soln. to be tested with 0.5 cc. of 5% KI soln., and introduce 1 cc. of strong H_2SO_4, by means of a pipet, below the surface of the liquid so as to form a second layer. If Sn is present small characteristic yellow crystals of Sn iodide begin to sep. at the surface between the two layers. The ppt. is sol. in HCl, which should therefore be kept at a min. in the test soln. As and Sb interfere with the test. J. S. C. I. (*C. A.*)

44. Physical chemistry and ceramics. E. W. WASHBURN. *J. Franklin Inst.*, **193**, 749–73(1922).—Sections are devoted to: colloid chemistry and ceramics; heterogeneous equil. at high temps. including the dissociation of kaolin and phase-rule diagrams; properties of silicate solns. at high temps., including soly. of gases, viscosity, density, and elec. cond.; high temp. calorimetry; and standard methods of testing ceramic materials. See *Ceram. Abs.*, **1**, 226(1922). JOSEPH S. HEPBURN (*C. A.*)

45. The titration of zinc. E. MONASCH. *Pharm. Weekblad*, **58**, 1652(1921).—The thiocyanate method of Kolthoff and van Dijk (*C. A.*, **15**, 3047) has been applied to the estn. of Zn in alloys. The potassium mercuric thiocyanate soln. is prepd. by dissolving 23.7 g. of $Hg(CNS)_2$ in a concd. aq. soln. of 14.4 g. of KCNS, and is stable for many months. Compds. of all the common metals interfere, but ferric and Al salts do not affect the reaction. Since M. uses Al in the sepn. of Zn from alloys, the method is suitable for the estns., but Fe salts must first be oxidized by means of peroxide. J. C. S. (*C. A.*)

46. Colloid chemistry. JEROME ALEXANDER. *J. Ind. Eng. Chem.*, **14**, 800–2 (1922).—Colloid chemistry is a distinct zone in the chem. field. Many theoretical and tech. applications are given. No new data or theories are presented. F. E. BROWN (*C. A.*)

47. Chemical reactions on surfaces. IRVING LANGMUIR. *Gen. Elec. Rev.*, **25**, 445–54(1922).—See *C. A.* **16**, 7. C. G. F. (*C. A.*)

48. Volumetric estimation of potassium. MACHELEIDT. *Woch. Brau.*, **39**, 23–4 (1922).—Prep. a standard soln. of NaH tartrate by dissolving 60 g. of tartaric acid and 16 g. of NaOH in water and dil. to 1 l. Add 6 g. of KH tartrate and shake the soln. for several hrs. Filter off 30 cc. and titrate with 0.1 *N* $Ba(OH)_2$ soln. Shake a second 30 cc. for 1 to 2 hrs. with 0.5–0.75 g. of the salt mixt. to be tested, filter the soln. into a tared basin and, without washing the filter, titrate with the $Ba(OH)_2$ soln. Weigh the soln. before and after filtering, and make allowance for the loss. The difference between the two titrations is calcd. to K_2O. J. C. S. (*C. A.*)

49. Chemical constitution of zeolites. G. TSCHERMAK. *Sitzb. Akad. Wiss. Wien*, **126**, 541–606(1917); **127**, 177–289(1918).—Twenty-one new analyses are given of various zeolites. In all cases the ratio Al : Ca(Sr, Ba) + $Na_2(K_2)$ is 2 : 1. Omitting O all zeolites may be represented by the formulas $Si_xAl_2CaH_{2y}$ and $Si_xAl_2Na_2H_{2v}$, where x and z range from 2 to 10, and y and v from 2 to 9. Or again, neglecting H, they all contain a group $Si_2Al_2CaO_8$ or $Si_2Al_2Na_2O_8$. This group is regarded as a nucleus ("Kern") and represented as *Kc* or *Kn*, respectively (also *Kb* and *Ks* for the corresponding Ba and Sr nuclei). The various zeolites are regarded as compds. of one or other of these nuclei with a silicic acid, combined H_2O and water of crystn. The silicic acid and water of hydration are supposed to form a network enclosing the nuclei. Such a structure is regarded as offering an explanation of the variation of the optical characters of the

zeolites with loss or gain of water, the various adsorption phenomena, and the ease with which the bases may be replaced. The following is a summary of the different groups: *A*. Orthosilicates in combination with SiH_4 and H_2O: Natrolite, SiH_4Kn = $Si_3Al_2Na_2H_4O_{12}$. Scolecite, SiH_4KcOH_2 = $Si_3Al_2CaH_6O_{12}$. Mesolite, a double salt of these two in the ratio 1 : 2. Edingtonite, SiH_4KbOH_2, aq. = $Si_3Al_2BaH_8O_{14}$. Gismondine, $H_2OKcO_2H_4$, aq. = $Si_2Al_2CaH_8O_{12}$, also with SiH_4 in place of H_2O. Laumontite, $SiH_4K\acute{c}SiH_2$ = $Si_4Al_2CaH_8O_{16}$. Thomsonite, a double salt of the compds. H_2OKnOH_2 aq. and H_2OKcOH_2 in the ratio 1 : 3; also in the latter SiH_4 in place of H_2O. *B*. Disilicates combined with polysilicic acids and H_2O: Analcite, Si_2H_4Kn = $Si_4Al_2Na_2H_4O_{12}$, also with Si_4H_8, Si_4H_4, or H_2O in place of Si_2H_4. Faujasite, $Si_4H_8KcO_2H_4$. 4aq. also with Si_2H_4. Chabazite, $Si_2H_4KcO_2H_4$. 2aq. = $Si_4Al_2CaH_{12}O_{18}$, also with Si_4H_8, Si_2H_2, or SiH_4. Gmelinite with *Kn* in place of *Kc*. Levynite like chabazite with Si_2H_2 and SiH_2. Stilbite, $Si_4H_8KcOH_2$. 2aq. = $Si_6Al_2CaH_{14}O_{23}$, also with Si_6H_{12}, Si_4H_4, or Si_2H_4. Harmotome with *Kb* instead of *Kc*. Phillipsite like stilbite but with Si_2H_4, Si_2H_2, SiH_4, SiH_2. Heulandite, $Si_4H_4KcO_2H_4$. aq. = $Si_6Al_2CaH_{10}O_{21}$, also with Si_6H_6, Si_4H_8, or Si_2H_4. Brewsterite with *Ks* in place of *Kc*. Mordenite like heulandite with Si_2H_8. J. C. S. (*C. A.*)

50. Recent advances in science—geology. G. W. Tyrrell. *Sci. Progress*, **17**, 35(1922).—Sections are devoted to recent work on the chemistry of metamorphic rock and on volcanology. Joseph S. Hepburn (*C. A.*)

51. Recent advances in science—mineralogy. Alexander Scott. *Sci. Progress*, **17**, 41–6(1922).—Review of recent work in mineralogical chemistry. See *Ceram. Abs.*, **1**, 160(1922). Joseph S. Hepburn (*C. A.*)

52. Theory of Brownian movement. G. Jäger. *Sitzb. Akad. Wiss. Wien*, (2*a*), **128**, 1271, 1298(1919).—Stokes's law is held to be inapplicable in the case of Brownian movement. It is shown from consideration of mech. examples that if this law holds, osmotic pressure must be exerted as a continuous force and the consequences of Einstein's equation for Brownian movement and the calcn. of mol. size from diffusion are justified. The distribution of energy for particles of any no. of mols. may be obtained from Maxwell's law directly by gradual building up of groups from mols. The velocity of particles relative to the liquid medium, including their Brownian movement, is only to a small degree dependent on their mass. J. C. S. (*C. A.*)

53. Some fundamental conceptions of colloidal chemistry. Electrical charge on particles and the new conception of "micelle." Richard Zsigmondy. *Z. physik. Chem.*, **101**, 292–322(1922).—A discussion. H. Jermain Creighton (*C. A.*)

54. Determination of calorific value of coal. F. S. Sinnatt and M. B. Craven. Lancs. Cheshire Coal Research Assoc., *Bull.* **10**, 23 pp.(1921).—Formulas for the calcn. of calorific value from the proximate analysis of coal (cf. Goutal, *Compt. rend.*, **135**, 477–9(1902)) are accurate when dealing with samples from the same seam except when the coal contains Ca or substituted Ca carbonates; the value for one of the samples should be detd. in a bomb calorimeter, the manipulation of which is described in detail. J. S. C. I. (*C. A.*)

Refractories and Furnaces

55. Quartz and flint in America. R. Rieke. *Trans. Ger. Ceram. Soc.*, **2**, 168 (1921).—Comparisons of quartz and flint as used in the American and German ceramic industries were made by measuring the rapidity of change to cristobalite when heated to 1430°C in a porcelain kiln by noting the lowering of the sp. gr. (cristobalite = 2.32). The results tabulated follow:

		Sp. gr. before burning	Sp. gr. after burning
Amer. Mat.	Silica Sand	2.67	2.49
	Quartz Rock	2.66	2.49
	Flint Pebbles	2.57	2.28
	Chalcedony	2.66	2.32
Germ. Mat.	Norwegian Quartz Rock	2.65	2.37
	Hohenbocka Silica Sand	2.65	2.59
	Flint (German)	2.63	2.23

These results indicate that care should be used in applying the results of American research to German raw materials. FRED A. WHITAKER

56. Grinding broken saggers. ANON. *Brick Pot. Trade Jour.*, **30**, 208-9(1922).—Good grog should have angular grains and be free from dust. An edge runner mill with a solid pan should be avoided as this has a tendency to produce round grains and considerable dust. A cylinder grinder with pebbles or balls should also be avoided as the rubbing action in this grinder produces an excess of dust. The various pendulum mills are also open to the same objection. Jaw crushers are excellent preliminary crushers but do not work economically when required to reduce all the pieces to less than $^1/_2$" in diam. Crushing rolls are excellent for reducing material from pieces not more than 1" in diam. to the required fineness. It is generally desirable to use two sets of rolls, one to reduce to $^1/_8$" and the other to finish the grinding. Specially designed edge-runner mills with revolving perforated pans can be used. They are more costly to maintain than crushing rolls. Ball mills with sepg. devices which remove the material as soon as it is crushed may also be employed. They should be fed with material not more than $1^1/_2$" in diam. Stamping mills are not efficient and are too noisy. Disintegrators consisting of a series of hammer bars mounted radially on a horizontal shaft are the best for crushing grog. They require to be fed with pieces not more than 2" in diam. A sieve is desirable to remove the coarse and fine grog with any grinder in order to produce a grog of max. quality. H. G. SCHURECHT

57. The volatilization of silica in the manufacture of refractories in electric furnaces. RI. *Deut. Töp. Zieg. Ztg.*, **53**, 221–2(1922).—Amorphous SiO_2 containing 99.15% hydrated silica and which deformed at cone 35 was placed in a crucible and heated in an elec. fur. in an oxidizing atmos. at cone 39. No appreciable volatilization was noticed. When this same SiO_2 was placed in coke blocks and heated in the same fur. the SiO_2 volatilized rapidly and was deposited in the cooler portions of the kiln. Similar expts. were made on a number of substances and the ingredients which volatilized detd. by chem. analysis (see Table I). I is a fusible brick clay; II a feldspar, III a second grade fire clay, IV a good fire clay, and V a highly refractory kaolin. VI, VII, and VIII are mixts. of kaolin with MgO, CaO and K_2O. In all cases the SiO_2 volatilized more than the Al_2O_3. The alkalies volatilized more than the SiO_2. The product which condensed on the cooler portions of the kiln was composed principally of K_2O and SiO_2 with small amts. of Al_2O_3 and CaO. The volatilization of SiO_2 in a reducing atmos. is explained by reduction of the SiO_2 which would liberate the extremely volatile Si. H. G. SCHURECHT

58. Basic slag manufacture, Great Britain. ANON. *Chem. Age*, **7**, 315(1922).—According to an interim rept. just made to the Minister of Agric. there is some likelihood of their being a diminution in the supplies of basic slag next season. The rept. is made by a permanent Comm. appointed by the Minister to consider the development and improvement of the manuf. of basic slag and the extension of its use, and it contains a record of their expts. and results during last year. The demand for ground basic slag by the farmers of the United Kingdom has doubled since 1912. Production

TABLE I

	I		II		III		IV		V		VI		VII		VIII	
	Burned	Melted	Burned	Melted	Burned	Melted	Burned	Melted	Burned	Melted	Burned	Melted	Burned	Melted	Burned	Melted
SiO_2	64.91	64.01	65.48	64.97	72.82	68.71	59.59	53.23	55.05	50.37	51.76	43.85	51.40	50.67	51.83	48.49
Al_2O_3	11.90	14.81	19.00	20.86	21.48	26.40	33.90	41.65	41.56	46.94	39.07	43.71	38.80	41.04	39.22	46.21
Fe_2O_3	17.39	16.39	0.28	0.21	2.00	1.78	2.76	1.90	1.25	1.06	1.17	0.68	1.17	1.20	1.18	1.07
Mn_2O_3	2.09	2.45	...	...	...	...	...	...	...	...	...	...	...	...	...	...
CaO	1.09	0.99	0.50	0.25	0.68	.4	0.38	tr.	0.50	0.23	0.47	tr.	7.11	6.79	0.48	0.11
MgO	1.40	1.11	0.39	0.38	1.11	0.98	0.96	0.87	0.29	0.34	6.52	11.70	0.25	0.20	0.24	0.34
K_2O	0.92	0.13	14.22	13.06	2.27	1.96	2.61	1.95	1.06	0.75	1.28	0.35	1.24	0.32	7.48	3.61
Na_2O	...	...	0.36	0.21	...	...	...	...	...	...	...	...	...	...	...	...
Cone	3	2–3	14	16	28	27	32	35	35	37–38	15	14	27–28	26	28	35–36

has not likewise increased and in 1920 and 1921 was considerably less than the demands. There has been a reduction in quality owing to the supersession of the Bessemer process by the open-hearth process. The slag now obtainable contains only half the percentages of phosphate of pre-war days, and much of it shows reduced soly. The demand has been met to some extent by importation but it is likely that the quality of basic slag manufd. on the continent may decrease, as it has in the United Kingdom, as a result of a similar change in process. With regard to the possibilities of increased or improved production, there has been little change in blast-furnace or steel-furnace procedure as for the purpose of improving either the output or the quality of slag. From the steel makers' point of view, basic slag is relatively unimportant. The practical result is that the compn. of basic slag is detd. by the conditions under which the steel-maker is working, and the total amt. producible is regulated by the demand for steel. The use of such substitutes as ground mineral phosphates would afford a ready means of solving the problem. The fertilizing value of these phosphates is being investigated. It is proved that high sol. open-hearth basic slags have the same agricultural value per unit of phosphoric acid as the old Bessemer slags and that low sol. slags and mineral phosphates have a smaller value. The Comm. express the hope that they may ultimately be able to map out the country into regions where the high sol. slag can effectively be replaced by low sol. slags and mineral phosphates. They also hope to ascertain whether very low grade slag could be used with an admixture of mineral phosphates. The rept. concludes with the suggestion that the official soly. test needs revision.

O. P. R. O.

59. One piece furnace lining. I. S. PIETERS. *Iron & Steel of Canada*, **5**, 156 (1922).—Discusses the merits of the one-piece monolithic lining for refractory fur. compared with the brick lining. In the former there are no joints to cause weakness, to serve as channels for cold air to enter the fur.; no bricks to loosen and fall out; no cement to fuse and disappear and no unequal expansion and contraction. There is no chem. action between different substances. The lining material is chosen for its ability to withstand heat and fur. conditions. The life of the fur. has been increased up to 500%, reducing the cost of upkeep proportionally. It has enabled boilers to operate for more than a year and sometimes for 2 yrs. without a shut down for fur. repairs where with brick, a new lining was required several times a year. It has increased combustion efficiency thus lowering the cost of fuel. Boiler evapn. has been increased economically far beyond the range formerly possible with economy.

O. P. R. O.

60. Graphite in Canada. V. L. EARDLEY-WILMOT. *Can. Inst. Min. & Met. Trans.*, **26**, 124(1922).—For commercial purposes, it is convenient to distinguish three varieties of graphite: crystalline, flake and amorphous. Flake graphite occurs disseminated through the containing rock, whereas the crystalline forms true veins of more or less compact graphite. Amorphous graphite approaches coal in its physical characters, and is often found in contact with coal seams, shales and slates. Graphite mining in Canada is confined to the provinces of Ontario and Quebec. E.-W. describes finishing and polishing, and flotation systems. Samples of Canadian graphite were submitted to all known crucible makers, but the general verdict was that although from the chemical standpoint Canadian graphites are as good as, or even better than the Ceylon graphite, they are inferior in physical characters. Re-floating in the Callow cells, followed by careful tabling and screening, has produced an 80-mesh, 87 to 90% concentrate, distinctly more angular, and denser than ordinary "finished" products. These samples have been submitted to crucible makers who reported this "natural" flake as good in every way as the best Ceylon graphite, and that it could be used in the crucible industry. Graphite mills and operations are described. O. P. R. O.

61. Fire brick. ANON. *Industrial Canada*, **23**, 94(1922).—A hitherto unknown industry in Canada is to be established by the Canadian By-products Co. Ltd., at Hamilton. They purpose mfg. fire brick, fireproof building brick and tile, under 4 basic patents. The plant will have a capacity of 20,000 fire brick and miscellaneous refractories and will be able to supply the demand hitherto supplied by importation from U. S. and Scotland. O. P. R. O.

62. Notes on jointing materials for refractories. L. BRADSHAW AND W. EMERY. *Trans. Ceram. Soc.* (Eng.), **21**, 107–16(1922).—In general, the jointing material used for laying fire clay bricks consists of a mixt. of ground raw clay and grog, with or without sand, while for silica bricks, crushed silica with a small propn. of fire clay is employed. It is well known that the softening temp. of silica fire clay mixt. is lower than that of either constituent. The authors found that the curve for fusion points of mixt. of finely crushed silica brick and fire brick corresponded roughly to Seger's curve for pure silica. When tested under load of 35 lbs. per sq. in., the values fall into the same order as those of the ordinary refractoriness, but the curve is steeper on the silica side and flatter on the fire clay side, *i. e.*, the differences between the softening temp. with and without load are less in the case of siliceous mixt. than for mixt. rich in fire clay. The softening point under load of 100% fire clay brick grog was cone 20. The introduction of 40% silica brick lowered the softening point only to cone 19. When coarser grained mixts. are substituted for those used in the foregoing experiments, the effect upon the softening point is less marked. In the prepn. of mortars for fire clay bricks, the addition of grog to fire clay is a general practice. The grading of sizes and proportioning of the materials used are of prime importance. The effect of mixing carefully graded materials in various propn. was studied. The coarsest grade used all passed 20-mesh. When the material has a high contraction, cracks develop during the air-drying, while in other cases they appear only after firing. These cracks are invariably transverse, *i. e.*, across the joint, owing to the shrinkage along its length. Longitudinal cracks generally do not appear. A briquette of fine clay forms a hard compact mass free from cracks, which offers very high resistance to crushing and slag penetration. The same clay, after firing between bricks, exhibits large fissures into which slag can penetrate freely. The sharp increase in the contraction of the clay with diminishing grain size of clay was clearly shown, as also the corresponding increase in mechanical strength and the resistance to slag penetration. The addition of grog largely reduces the contraction and allows a greater penetration of slag. Of the mixt. examd., those composed of mixed grades of clay and grog appear to give the best results. These mixts. are mechanically strong, have a sufficiently small contraction, and set between bricks to a hard compact mass, which is free from cracks and is not easily attacked by molten slags. The addition of sand diminishes the fire-shrinkage, but renders the mixt. friable. It is evident that the prepn. of a suitable mortar is mainly a question of balancing the opposing qualities of its constituents. H. F. S.

63. The influence of oxidizing and reducing atmospheres on refractory materials. L. BRADSHAW AND W. EMERY. *Trans. Ceram. Soc.* (Eng.), **21**, 116–52(1922).—Seger cones heated in a current of coal gas remained erect at temps. far above their normal softening points. These cones were found to consist merely of a hollow shell with a quantity of slag discharged at the base, or of a semi-vitrified mass covered with an infusible skin. The outer shell is extremely refractory. The effects are observed not only in the lower cones containing borax frit, but also in the higher ranges of cones which are free from borax and other volatile matter and also free from iron. It appears to be due to the formation of a thin film of hard carbon in intimate contact with the surface of the cone. It has been found possible to drain off the slag from the interior, leaving the outer shell intact. The cone is mounted over a hole of suitable size bored

through a thin refractory plate which forms the lid of a hollow cylinder of the same material. On heating in a current of coal gas to a temp. considerably above the normal softening point of the cone, the viscous material is discharged into the receptacle below, while the refractory shell remains standing and appears from the outside unaltered. The surface deposition of hard carbon is also observed with test pieces of fire clay brick heated in an atmosphere of coal gas. The refractoriness of the shell is so very much higher than that of the untreated material that if the fact can be applied practically, it should be possible to make a super-refractory from the purer clays. The imparted refractoriness might not endure under working conditions. H. F. S.

64. Graphite in Siberia. ANON. *Raw Materials Rev.* (London), **1**, 155(1922).—As the result of various hydrographical and geological expeditions which recently investigated parts of Siberia, deposits of graphite have been found on the River Kureiki, a tributary of the Yenisei. These are estd. to contain at least 200,000,000 roods, or enough to satisfy the requirements of the world for several decades. Deposits of graphite have also been noted along the River Podkamennoi Tunguske, together with extensive measures of coal and cupreous nickel ores. O. P. R. O.

65. Illinois fire clays. C. W. PARMELEE AND C. R. SCHROYER. Illinois State Geol. Surv., Ext. from *Bull.* **38**, 149 pp.(1921).—A proposed new classification of clays according to use includes: I, clays burning white or cream colored, not calcareous; IA, open burning, porous at cone 15; IB, dense burning, non-porous or nearly so at cone 10–15; IC, dense burning, non-porous or nearly so at cone 5–10; II, buff burning clays; IIA, refractory; IIB, non-refractory; III, clays burning red, brown, or other dark color; IIIA, open burning, not attaining low porosity until near or at the fusing point; IIIB, dense burning with a more or less extended vitrification range; IV, clays burning dirty white, cream or yellowish white. Further subdivisions are given and the typical uses for the different classes are given. The various types of clays are described and methods of conducting the physical tests are detailed. The geology of Illinois clays is reviewed and many deposits are described. Judged by their physical properties the samples are classified as follows: refractory clays showing a porosity of 5% or less at cone 9 or under, 20; refractory clays showing porosity of over 5% below cone 9, 30; stoneware clays, 48; architectural terra cotta clays, 53; sewer pipe clays, 9; face brick clays, 45; common brick, tile, etc., clays, 10; sanitary ware clays 48. The same clay may appear in more than one of the above classes. C. H. KERR (*C. A.*)

PATENTS

66. Insulating cement or mortar. ARTHUR S. ELSENBAST and WALTER J. JORDAN. U. S. 1,421,192, June 27, 1922. An insulating cement comprising powdered diatomaceous earth, clay, and starch. C. M. S., JR.

67. Composition for producing coatings on refractory articles. WILLIAM ROY MOTT. 1,425,603, Aug. 15, 1922. As a new article of manufacture, a refractory article provided with a coating comprising an oxy-compd. of boron, associated with iron and chromium. C. M. S., JR.

68. Refractory silica brick and process of manufacture. ORAZIO REBUFFAT. Italy. 1,420,284, June 20, 1922. The process of rapid conversion of quartz into its allotropic varieties of lower specific gravity by incorporating therein small quantities of the radicals of acids nonvolatile at high temperature and calcining the same and recovering the allotropic varieties of the quartz of lower specific gravity than quartz. Cf. *Jour. Amer. Ceram. Soc.*, **4**, 945(1922). C. M. S., JR.

BOOK

69. SEXTON, A. HUMBOLDT: **Fuels and Refractory Materials.** Revized and enlarged edition. Edited by W. B. Davidson. New York: Van Nostrand Co. 382 pp. $4. Reviewed in *Am. Gas J.*, **116**, 561(1922). (*C. A.*)

Abrasives

70. Greek emery exports. ANON. *Oil and Colour Trade Jour.*, **62**, 615(1922).—The export of emery stone is yearly increasing in importance. O. P. R. O.

71. Bauxite in India. L. L. FERMOR. *Geol. Surv. of India, Records*, **53**, 250(1922).—Extensive deposits of bauxite have been found in India, which compare in quantity very favorably with the Irish, French and American bauxites. In order of importance these deposits are located in the Provinces of Bombay, Bihar and Orissa. The analyses given indicate these bauxites are of great economic value. O. P. R. O.

72. Corundum in the Northern and Eastern Transvaal. A. L. HALL. Union of S. Africa, *Geol. Surv., Memoir*, **15**, 1920.—In a region of 200 sq. mi., corundum occurs in several forms: (1) crystal corundum, found in loose crystals in shallow alluvial deposits, (2) boulder corundum in loose blocks embedded in a matrix, and more resistant to weathering, (3) reef corundum, in vertical veins intrusive in the basic formation, and commonly a few feet or yards thick. In the Plateau region the corundiferous reefs are felspathic while in the low country reefs are characterized by margarite instead of feldspar. The crystal, boulder and reef corundums have been exploited commercially, with very favorable results. Large quantities of corundum are available and for commercial plumasite or marundite ore bodies, a corundum content of from 30 to 60% is a conservative estimate. In the absence of nepheline and allied alkaline rocks, the Transvaal fields are not comparable to the Ontario corundum-bearing localities, but they show many points of resemblance to those of the eastern U. S., and to certain deposits in Natal. From the economic point of view, the S. African corundum fields are the most extensive and richest in the world. The deposits contain the makings of a valuable industry, notwithstanding the severe competition of artificial abrasives. Among the conditions to be arrived at are (1) more uniform methods of grading, (2) maintaining a definite and high standard of purity, and (3) closer contact between producer and consumer. The export of graded corundum in grain form, instead of the present shipments of crystal corundum in different conditions of purity (freedom from gangue) would do much toward establishing a future corundum industry on a permanent economic footing, leading up to the manuf. of abrasive tools. Illus. and bibliography on corundum. O. P. R. O.

73. The east Adriatic bauxite. F. KERNER-MARILAUN. *Montan. Rundschau*, **14**, 73–8(1922).—A description of the geological occurrence and characteristics of several types of bauxite. R. S. DEAN (*C. A.*)

Stoneware, Whiteware and Porcelain

74. Porcelain fittings for wireless. ANON. *Times Trade Supp.* (London), **101**, 218(1922).—The development of wireless broadcasting and the popular demand for wireless receiving sets have called for elec. porcelain fittings of new and particularly exacting design. Practically every piece of elec. app. necessitates some porcelain fitting, so that all these provide some new business for elec. porcelain manuf. High-tension generating and distributing installations necessitate porcelain of greater durability and higher insulating property than formerly, and wireless plants require new types of insulators. English manufacturers are able to meet the demand effectually, in face of keen German competition. O. P. R. O.

75. The manufacture of pottery. ANON. *Brick. Pot. Trades Jour.*, **30**, 207–8 (1922).—Wet mixing is preferred to dry mixing. The ware is biscuited at 1100–1300°C in 45–70 hrs. and cooled in 48 hrs. Glost burn is at 900–1100°C and decoration is done at 600–850°C. H. G. SCHURECHT

76. The heating of a porcelain oven by means of fuel oil. J. CHAUVISÉ. *Bull. officiel direction recherches sci. ind. inventions*, No. **32**, 326–39(June, 1922).—Satisfactory results have been obtained at the Manufacture Nationale de Sévres. A. P.-C. (*C. A.*)

77. Translucency of porcelain. W. STEGER. *Trans. Ger. Ceram. Soc.* **2**, 9(1921).—By observing the increasing translucency of porcelain during burning a valuable check on the maturing process can be obtained. The translucency increases as the smaller sillimanite crystals are gradually merged into larger ones. The following methods of comparing translucency are described: (1) Hand method of judging the sharpness of the contour of the hand when held between the porcelain and the light. (2) Screen method (*Trans. Amer. Cer. Soc.*, **13**, 102(1911)). (3) Wedge method (*ibid.*, **17**, 150, (1915)). (4) Martens photometer (*ibid.*, **17**, 150(1915)). (5) Bouguer photometer. (6) Weber photometer. FRED A. WHITAKER

78. The solubility of coloring metal oxides in china glazes. R. RICHE AND ING. W. POETSCH. *Trans. Ger. Ceram. Soc.*, **2**, 77(1921).—In melting a glaze containing a metal oxide four possiblities present themselves: (1) Mechanical suspension of the oxide as such in the glaze instead of solution. (2) Solution under heat but crystn. during cooling. (3) Complete or partial crystn. if glaze is supersaturated. (4) Oxides react with the other components of the glaze to form silicates, borates, etc. The effect of various metal oxides in combination with 4 glazes of the following types was studied: (1) A soft lead, low alkali, boric acid glaze for cone 09. (2) A leadless boric acid glaze also for cone 09. (3) A harder glaze for cone 2*a* with only traces of boric acid. (4) A commercial leadless glaze for cone 2*a* containing no boric acid. It was established that the chem. compn. of the glaze rather than the m. p. detd. its capacity for dissolving oxides. Glazes low in Al_2O_3 showed the highest soly. The above combination of glazes and oxides was later ground fine and reburnt as glazes on a china body and in no case was there any sign of crazing. F. Kraze arranges the oxides as anti-crazing agents in the following order: Co, Cu, Cr, Mn, Fe, Zn, Ba, Ca, Mg, K, Na. In testing the oxides for properties as underglaze colors it was found that Cr_2O_3 showed the least soly. in all 4 glazes and gave the sharpest lines. FRED A. WHITAKER

79. Translucency of porcelain. W. STEGER. *Trans. Ger. Ceram. Soc.*, **2**, 63(1921).—Tests with simple porçelain bodies composed of kaolin, quartz and feldspar showed: (1) Translucency is inversely proportional to thickness. (2) Curves plotted to show the relationship between thickness and translucency of the different bodies form straight lines and run exactly parallel where ratio of quartz to feldspar is the same and the translucency increases as the clay substance content decreases. (3) By extending these to their intersection with the ordinate (thickness = 0) values were established and plotted against the clay substance content of these test bodies and again a straight line resulted. Supplementary tests with a more complicated porcelain containing ball clay gave a curve running almost parallel with those obtained with the test batches which led to the supposition that the ratio of quartz: feldspar was approximately the same as in these. Following this out as in (3) a theoretical clay substance content of 57% was indicated and later confirmed by rational analysis. This indicates the possibility of detg. the approx. rational analysis of a porcelain by measuring the translucency and comparing it with standard porcelains. FRED A. WHITAKER

80. Malaya's new pottery industry. ANON. *Jour. Roy. Soc. Arts*, **70**, 676(1921).—This plant introduces an entirely new industry in the country. It is equipped to handle all the processes from refining the crude clay to the decoration of the completed piece and is situated about 16 mi. from Ipoh. Casting and jolleying are the processes used, permitting a comparatively large output with labor that is not yet thoroughly trained. Teapots, jugs, ewers and basins are already being turned out by Malay girls who had never seen a pottery until a few weeks ago. All the required materials are found within

3 mi. of the works and besides supplying its own clay the company ships china clay to cotton mills in Bombay and paper mills in Calcutta. The barrels for packing the product are also made at the works. O. P. R. O.

81. Fine grinding in the potteries. EDITORIAL. *The Engineer* (London), **134,** 222(1922).—Alsing introduced the tube mill in 1870 for the grinding of calcined flints in the Staffordshire potteries. Inquiry shows us that the tube mill, which has come so much into favor in other industries, among which metallurgy and cement making may be mentioned, has really made but little progress in ousting its only rival, the wet chert mill, from local favor. The chief advantage lies in first cost. It is now not far short of 150 years since Brindley brought out the wet grinding mill or "pan," at the behest of Wedgwood, who had just initiated the use of flint in pottery, and decided upon the use of chert or hornstone as the abrasive medium. There is practically no difference in the design of the pans to be seen in operation today from those in use a century ago or at the time of their introduction. Only a few potters do their own grinding, which is a separate business carried out by milling firms. They buy the siliceous materials in bulk and sell them in the form of slop to the pottery manufacturers. The chert grinding is in the form of a mortar mill, 14 ft. diameter and 3 ft. high, the bottom being lined with chert blocks about 1 ft. thick. Over this bed 4 large blocks of chert called runners, fixed to 4 arms at right angles, revolve at a speed of 15 r. p. m. A common wt. for these runners is 16 cwt., though much heavier stones have been used. The pulp from these mills has to pass a 140-silk or wire mesh. The tube-mill has the advantage in first cost but it is not the mill proper which represents expense in the chert pan but the heavy gearing, a considerable amt. of power being required to start and run it. Almost as much is required for a tube mill of similar capacity at the start, but afterward the power required is considerably less than with the chert mill. Those who have installed the tube mill say that it effects an economy, but this does not seem to amt. to a great deal if the saving does not exceed one shilling per T. of material ground, as it is claimed. A point in favor of the tube mill has been brought about by the present high price of chert. The tube mill occupies less space than the older grinder and need not necessarily be put on the ground floor. Against the tube mill, is the heavy hand of certain potters, who specify in contract that slop be the product of the chert pan. As long as this preference exists there is no likelihood of the chert pan being scrapped in favor of its younger rival. For some time, both systems of grinding will be carried on in close propinquity. For the first time in its long existence an important grinding mill in the potteries has just had a tube mill erected close to its battery of chert mills, and the various verbal reports as to the relative economy of the systems will be added to by another based on carefully recorded data. The necessary facilities exist for making trials of the relative systems which may be taken as comparative and free from bias. With regard to the flints used in the tube mills, the Staffordshire millers are in a good position, as those best adapted for the purpose are selected from the heap awaiting calcination and grinding. An important attribute of chert as a grinding medium is that its gradual wearing down does not add any deleterious foreign matter to the flint, as would be the case if certain other stones were used. O. P. R. O.

82. Pottery. ANON. *Chem. Eng. & Min. Rev.*, **14,** 369(1922).—A unique display of W. Australia pottery was held in Perth recently. The exhibition comprised a most interesting collection of W. Australian pottery clays and a wide range of articles, from bricks to semi-porcelain ware, from glass bottles to Hume concrete pipes. O. P. R. O.

83. Spit-out of glazes on passing through an enamel kiln. JNO. MILES. *Trans. Ceram. Soc.* (Eng.), **21,** 208–26(1922).—Spit-out faults are really due to small bubbles of gas, which, coming chiefly from the pores of the body, pass through the glaze when the latter becomes viscous while in the enamel kiln, leaving the surface of the glaze

more or less rough. The gas is generally superheated steam generated from moisture in the body. If the glaze remains soft enough in the enamel fire for a sufficient length of time, these gases will make their exit and the glaze surface will become smooth. In drying ware before putting it into the enamel kiln, the point where the glaze is broken must be the topmost point of the piece. To reduce spit-out losses, it is necessary (1) to avoid flash firing in biscuit; (2) to fire the glaze well up in glost; (3) to avoid damp atmosphere and water in the glost warehouses, and (4) to allow no rushing in firing enamel, especially between 650 and 800°C. In the discussion it was claimed that other factors, in addition to steam, such as carbon, in the body might cause spit-out. H. F. S.

84. Closed circuit grinding. J. C. FARRANT. *Trans. Ceram. Soc.* (Eng.), **21**, 125–52.—"Closed circuit" signifies that the material which is insufficiently ground is sepd. out by a classifier and returned to the mill for regrinding. The system of closed circuit grinding applies both to wet and dry reduction. This paper deals particularly with the use of Hardinge mills for the grinding. Tests have shown that in closed circuit wet grinding: (*a*) if the balls or pebbles are large and speed of mill is high, crowding will appear at the finer sizes in oversize; (*b*) if the balls are small or the speed is low, crowding will appear at the coarser sizes in the oversize; (*c*) the product from a mill with large balls and high speed will be more uniform than the product from a mill with low speed and small balls. The author gives examples of the use of Hardinge mills in grinding iron ore, barytes and flint, then concludes: "In the foregoing examples, the finished products ground at the various plants were detd. more by the size of the largest particles than the amount of "slime" or "flour" that was produced. In grinding to the potters' requirements this method of detg. the critical grinding point will not hold good because it is necessary to produce a more or less fixed propn. of "slime" or exceedingly fine material, in addition to grinding through a given lawn. In order to meet the grinding requirements of the pottery trade, it will be necessary to feed the grinding mill at such a rate that a max. amt. of the desired product is obtained per h. p. H. F. S.

85. Factory preparation and burning of whiteware bodies. ARTHUR S. WATTS. *N. J. Ceramist*, **1** [2], 91–6(1921).—A discussion of the prepn. and burning of whiteware bodies covering briefly the following topics: (1) raw materials, (2) cleaning dirty ball clay, (3) mixing the body, (4) prepn. of stain. The author recommends the following as the correct propn.: to 750 oz. of pure water add 15 oz. pure cobalt sulfate and stir until dissolved. Then add 7.5 oz. carbonate of soda. The proper propn. of stain to body are: for a body contg. 10% ball clay, add 75 oz. of stain soln. to each 1500 lbs. of body. For bodies with higher ball clay content increase the stain addn. in the same ratio up to 15% ball clay. For stain in glazes add 10 oz. of stain to each 100 lbs. of dry glaze. Glazes high in lead require more stain. (*a*) *Sieves.*—Revolving sieves are less costly and do not clog so easily. (*b*) *Filter press pressure.*—Max. pressure should be 80 lbs. for a body free from ball clay. Add 2 lbs. for every 1% of ball clay present. When the press stops running water, increase the pressure 10 lbs. for a few min. (*c*) *Aging and its effect.*—The temp. of clay cellars should be kept above 80°F and the relative humidity should be 90°. Aging is bad for elec. porcelain since it gives rise to gas blebs in the body. (*d*) *Plasticity.*—Plastic clays are either "greasy" or "sticky." Eng. and Amer. clays differ in this respect. "Greasy" plasticity is preferable. (*e*) *Pug mills.*—A slow rate of pugging produces an open body. A faster rate produces a granular, weak body. Too much speed causes the clay to heat. (*f*) *Setting the kiln.*—The first and second rings should be set 1″ apart, except midway between the cuts, and the inside rings all set a like distance. Leave a 1-in. opening between all rings. Not more than 6″ should be left between the top of the bungs and the crown at any point.

In downdraft kilns, the center of the kiln may be set 12 to 15" below the crown, and the burn improved if an opening is provided from top to bottom in center. (*g*) *Kiln firing.*—For burning hard-fire porcelain, free from ball clay, with the body biscuited, the glost fire may progress as fast as the coal will burn, maintaining a condition bordering on reduction from the time the kiln is hot enough to develop such a condition, *i. e.*, from about the tenth hour. For best results, the fuel beds must never burn low enough to leak any air, as a highly oxidizing condition is as dangerous as a condition of extreme reduction. The temp. is dropped fast after finish to an orange-red, then closed and cooled slowly. By this plan it is possible to burn a 16-ft. kiln to cone 15 in 20 hrs. (*h*) *For sanitary ware and elec. porcelain* the author gives the method of firing in considerable detail. C. W. PARMELEE

86. Zircon spark plug porcelain. G. A. PRITCHARD. *N. J. Ceramist*, **1** [2], 145–6(1921).—Porcelain made by the use of zirconium silicate has three important properties: high dielec. strength, great mechanical strength and great resistance to temp. changes. Zircon spark plugs have been heated to a temp. of 2400°F, and plunged into ice cold water without development of cracks. C. W. PARMELEE

87. The use of stain in bodies. C. W. PARMELEE. *N. J. Ceramist*, **1** [2], 117–25 (1921).—The principles involved in the correction of color of whiteware bodies by the choice of materials; use of reducing fire; use of stains. The compn. of stains, insoluble stains; use of cobalt salts, particularly the sulfate; general directions regarding the proper amt. of reagent necessary for pptn. of sol. cobalt salts in the body. C. W. P.

88. Sagger bodies and tests of same. W. STEGER. *Trans. Ger. Ceram. Soc.*, **2**, 142(1921).—Unusual ingredients mentioned are magnesite, corundum, zirconium oxide, carborundum. F. A. WHITAKER

89. Modern developments in German fine ceramic products, particularly in the manufacture of porcelain and faience. W. FUNK. *Z. angew. Chem.*, **35**, 81–3(1922).—A review and history with an outline of important problems to be solved, including the development of better fuels, better burning methods, the finding and using of new sources of feldspathic materials, the adaptation of German kaolins, the development of lower temp. hard porcelains which can be more economically produced, etc. C. H. K. (*C. A.*)

90. Dielectric strength of solid insulating materials. W. S. FLIGHT. *Elec. Rev.* (London), **90**, 39–41, 76–9(1922); *Science Abstracts*, **25B**, 157–8.—The author deals with the factors affecting the elec. strength of solid materials such as varnished cloth, micarta, mica paper, and flexible micanite. The following are touched upon: the test equipment; initial temp. of the insulation; thickness of insulation; shape of the insulating material; duration of application of voltage; thermal capacity of the electrodes; size and shape of electrodes; moisture content; tests carried out in air or in oil. Curves are given showing how the elec. strength varies with the no. of layers and also with the thickness of a fibrous material. The distribution across 3 layers of varnished cloth is plotted in the form of curves. The effect of time of application is illustrated by test curves on a micarta cylinder, oil-treated fuller-board, and varnished cloth. Test curves are also given showing the behavior of mica cambric under dry and humidified conditions. The author recommends that the temp. of the test sample and the electrodes should be approx. 90°. With reference to the length of time of application of the pressure, all figures should be based on the max. voltage that the material will withstand for one minute. This is detd. by first running up at the rate of 1 kilovolt per second and then attempting to apply 75% of the max. voltage for one minute. From the result of this second test the max. voltage the material will withstand for one minute can be ascertained. The area of the electrode should be 4 sq. in. Before testing, the test samples should be artificially dried and suspended for 24 hours in a humidifier at 25°. E. H. (*C. A.*)

PATENTS

91. Treatment of china clay or like clays. ANON. Pat. 183,535. *Chem. Age* (London), **7**, 320(1922).—A suspension of china clay in water is allowed to settle by gravity or is separated by mechanical means until it becomes a thick paste having a water content of about 50%. The material is then dried in an evapg. plant such as that described in Specification No. 149,055 (see *Chem. Age*, **3**, 292). In the drying plant the material is fed in a parallel series of thin films on to drying surfaces arranged in a number of chambers connected to operate in multiple effect. In this app. the drying surfaces are heated by vapor evolved from material being dried, the vapor being compressed to raise its temp. The process of drying the wet clay in blocks in a kiln by combustion gases is thus avoided, and the dry clay is obtained by a rapid and continuous method. O. P. R. O.

92. Preparing clay for making ceramic ware. G. W. LAPP. U. S. 1,424,924, Aug. 8. A slip is filter-pressed and the pressed cakes are subjected to pressure *in vacuo* to remove occluded air and gases. (*C. A.*)

93. Machine for working up ceramic masses into tiles, disks, and similar bodies. ERICH GERBEL. Germany. 1,420,093, June 20, 1922. In a machine for making disk-shaped objects and the like from ceramic masses, a vertically adjustable support for a mass block; means for truing the mass; means for successively cutting disks from the mass, and means for receiving and supporting the cut disks, the adjustable support and the disk cutting means being arranged for relative movement toward and from each other. C. M. S., JR.

Art and Design

94. Standardization of colors. H. TRILLICH. *Farben-Ztg.*, **27**, 672–4(1921).—See *Ceram. Abs.*, **1**, 256(1922). E. J. C. (*C. A.*)

95. Color standards. HANS HELLER. *Farben-Ztg.*, **27**, 2495–7(1922).—H. contests some of the suggestions of Trillich (see abstract above) and of Ostwald on the standard designation of colors. **Reply.** HEINRICH TRILLICH. *Ibid.*, 2556–7. (*C. A.*)

Heavy Clay Products

96. Elimination of waste-paving bricks. U. S. BUR. STANDARDS (Simplified Practice Recommendation No. 1), **1922.**—In accordance with the unanimous action of the joint conference of representatives of manufacturers, distributors, and users, the U. S. Department of Commerce, through the Bureau of Standards, recommends that recognized types and sizes of paving brick be reduced to the following list:

STANDARD SIZES AND VARIETIES

Standard Sizes

Width, inches	Depth, inches	Length, inches	Width, inches	Depth, inches	Length, inches
3	4	8½	3½	3½	8½
3½	4	8½	3½	3	8½

Standard Varieties

Plain wire-cut brick (vertical fiber lugless)				Repressed lug brick	
3	4	8½	3½	3½	8½
3½	4	8½	3½	4	8½

Vertical fiber lug brick			Wire-cut lug brick (Dunn)		
4	3	8½	3½	3	8½
4	3½	8½	3½	3½	8½
...	...	...	3½	4	8½

Hillside lug brick (Dunn)			Hillside lug brick (repressed)		
3½	4	8½	3½	4	8½

This recommendation describes the need for eliminating economic waste caused by the excessive variety in types and sizes of paving bricks, and shows the procedure used in reducing existing varieties from 66 to 7. The industry initiated the action through its trade association, and the Govt., through the Department of Commerce, endorses and publishes as its own those simplifications recommended by joint conferences of producers, distributors and users of the commodity. H. F. S.

97. Brick industry in New Brunswick. ANON. *Industrial Canada*, **23**, 72(1922).—An impetus has been given to the industry in N. Brunswick by the opening of a new plant at St. John, by the Stephen Brick Co. Modern equipment of the most efficient type has been installed. This includes a 150 h. p. engine and automatic machines for mixing clays, cutting brick, etc. Capacity will be between 50,000 and 60,000 bricks per day and there is an abundance of excellent clay alongside the plant. O. P. R. O.

98. Hollow building tile. WALTER A. HULL. *N. J. Ceramist*, **1** [2], 87–8(1921).—A brief abstract of an address describing work being done by the U. S. Bureau of Standards. C. W. PARMELEE

99. The "Pontam" system of paving. ANON. *Quarry & Surv. & Contractors' Journal* (London), **27** (1922).—This system was devised by the Société des Hauts Fourneaux et Fonderies, Pont-á-Mousson, France, and was first utilized 10 years ago; though the metal then employed was not so well suited as it is now, the roadway treated is still in perfect contition. The paving consists of (1) a layer of concrete of a depth varying between 0.1 m. and 0.2 m., according to the firmness of the ground on which it is laid, and (2) a layer of cement 1 cm. thick to level the concrete and take, before setting, a reinforcement of cast iron depressed pieces in the form illustrated below. This reinforcement is gently embedded in the cement, the depressions being placed downwards and so arranged as to resist sinking; the number of pieces laid range between 16 and 25 per sq. m., according to the traffic to be supported. Regularity in laying is ensured by means of a line, and uniformity of surface is maintained by templates and flat rulers placed on the materials. A surfacing of cement and small gravel (quartz or hard rock may be substituted) in the proportion of 0.8 kg. to 1 kg. of cement per cu. m., and a depth of 4 cm. covers the reinforcement. The surfacing has to be skilfully carried out in such a way as not to displace the reinforcement; it must also be done before the cement layer has completely set so that the two may be incorporated. Surface setting must take place gradually; under a hot sun the concrete is covered with old sacking, which can be watered now and then, likewise in winter, frost has to be guarded against. This mode of paving has many advantages. In the first place it can be fitted to all degrees of traffic, in the second it is non-slipping and non-tripping, the small part of the reinforcement at the surface running diagonally to the roadway, and it is very economical with regard to maintenance, being by French computation,

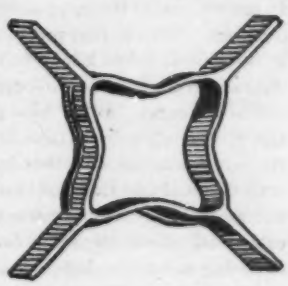


FIG. 1.

from 25 to 35% cheaper to maintain than other paving. Up to the present no roadways with this reinforced concrete paving have yet been opened for pipe laying, etc. In trench making, special care would, of course, have to be taken to conserve the symmetry of the reinforcement, because a number of pieces would necessarily be broken in the excavation, and their replacement requires time and skill. O. P. R. O.

100. The manufacture of tiles in East Africa. ANON. *Bull. Imperial Inst.*, **19**, [3], 297–311(1921).—The provision of roofing material for buildings in the tropics is often a matter of some difficulty. Corrugated iron is largely employed but is costly, and tends to make the building unbearably hot. In several countries in Africa it has been suggested that roofing tiles should be made locally, and search has been made for suitable materials. Specimens of clay and sand, collected in Uganda, and of clay, shale and diatomite from Kenya Colony, have recently been examd. at the Imperial Institute, and the results of the investigation are given in the present article. As diatomite does not seem to have been used hitherto for making roofing tiles, the trials now reported are of special interest. O. P. R. O.

101. Economical use of fuel in the manufacture of brick. GUNTHER. *Arch. Wärmewirtschaft*, **6**, 114–6(1922).—Brick are fired in the Hoffmann continuous kilns to a large extent in Germany. The customary manner in firing these is to throw coal in through holes in the crown from which it is allowed to fall to the bottom through spaces left between the brick underneath the holes. In a new method of firing these kilns, G. sets the brick so the coal does not always fall to the bottom of the kiln but it drops on brick grates placed at different elevations in the kiln. Thus the coal instead of burning at the bottom of the kilns burns in the middle and at $^3/_4$ of its height as well as at the bottom. These positions are clearly shown by diagrams. This method permits more uniform heat distribution in the kilns, better draft, increased production and economy in fuel. It was claimed that by changing from the old method of firing to the new that the time of firing was reduced 12%. The production was increased 15% in one case, 30% in a second and 40% in a third. A saving of 25–40% fuel was also obtained. H. G. SCHURECHT

102. The reddish brown color of sewer pipe. ANON. *Taschenbuch für Keramiker, Keram. Rund.*, **30**, 26–8(1922).—The firing of sewer pipe may be divided into 4 periods. In the 1st period the mechanical and chem. water is driven off and the bituminous matter oxidized. During this process the ware is fired with open fire causing an excess of air to be present in the kiln. In the 2nd period the kiln atm. becomes reducing due to the increase in temp. which necessitates a reduction of the incoming air. This changes the red iron compds. to the blue-gray forms. In the 3rd period the ware starts to shrink and vitrify when the rate of firing is gradually decreased. During this part of the burn the salt is introduced either in one round or three rounds. The salt can also be mixed with the coal and the mixt. fired during this period. The 4th period is the one in which the desirable reddish brown color is developed. In finishing the kiln all fires must extinguish about the same time. As the fires die down the kiln atm. becomes richly oxidizing due to the influx of air. The fire holes are then plastered up to keep the ware at high temps. with this oxidizing atm. as long as possible. This changes the blue-gray glaze to the desirable reddish brown color. If the fire holes are closed before the fire has completely burned, the remaining coal will burn with a strongly reducing smoke, causing the soot to combine with the glaze. This produces the dark glaze but not the desirable reddish brown glaze. This step requires a burner with considerable ability. If the coal is allowed to burn up entirely before the fire holes are closed it may allow too much cold air in, which would cool the kiln down below a point where it will not develop the reddish brown color but will cause the pipe to have a glaze which is too light in color. In order to det. the proper time to plaster up the fire holes a peep hole is placed just above

the fire door about 1″ in diam. By removing a plug one can observe exactly when the last of the coal has burned after which the fire holes should be closed. It may be necessary to handle different kiln slightly differently to produce the same results but when this has once been detd. the same conditions may be reproduced in later burns. It is also important to watch the draft gauge during the first 24 hrs. after the kiln has been finished and duplicate the best of these conditions in later burns. H. G. SCHURECHT

103. Blisters on sewer pipe. S. *Deut. Töp. Zieg. Ztg.*, **53**, 205, 206(1922).—One can often notice lump-like blisters on both the inside and outside of salt glazed sewer pipe. If broken open a hollow space is usually found underneath the blister. Similar blisters are often found in brick and are in this case attributed to the bituminous matter in the clay which has not been thoroughly oxidized before the outside of the brick vitrified. Since extremely plastic clays are used for making sewer pipe which are difficult to oxidize it seems probable that this may be the cause of some of the blisters on pipe. It is often claimed that these blisters are due to pyrites in the clay. The effect produced by pyrites is different however since this mineral causes small wart-like projections on sewer pipe. Clays often contain small amounts of H_2SO_4 which may also cause these blisters. Sulphates decompose liberating a gas before the ware is entirely matured which would cause the pipe to swell where these gases cannot escape. Firing with a reducing kiln atm. will decompose these sulphates at a lower temp. and hence reduce this trouble. In tracing the cause of blisters in a sewer-pipe factory it is well to start in the prepn. room. Entrapped air in pipe will often cause blisters before the pipes are fired. Insufficient pugging and storage of the pugged clay are often responsible for these blisters. If the clay is not thoroughly pugged it will contain considerable air which will be liberated as a blister in the subsequent pressing. Air thus entrapped will expand in drying causing the blister to swell up. If the clay is well pugged so it contains a uniform amt. of water throughout, if stored for some time after pugging and is fed into the press at regular intervals, little trouble due to blisters in the molding room will be encountered. H. G. SCHURECHT

104. The discoloration of brick. ANON. *Brick Pottery Trade Jour.*, **30**, 183–9 (1922).—Discoloration of brick may be caused by sol. sulphates of Na, K, Ca and Mg. Yellow and green colorations are sometimes due to V salts and are comparatively rare for though the salts are present in min. quantities in many clays there is seldom sufficient to cause trouble. This discoloration is not as easy to prevent as that due to sulphates. Firing in a reducing atmos. will reduce it. A further cause of this trouble is the salts introduced by stacking the brick on ground contg. ashes and occasionally by stacking them on concrete. In each case no harm is done when everything is dry but the trouble results when the ground or concrete is wet. H. G. SCHURECHT

PATENTS

105. Building brick. BERNARD F. WEBER. U. S. 1,425,302, Aug. 8, 1922. A composite wall or the like, comprising courses of hollow stretcher bricks with corner hollow header bricks all substantially the same size, and binder courses of the hollow header bricks, each stretcher and header brick presenting four plane unbroken surfaces, each stretcher brick having a web extending longitudinally therethrough and each header brick having two transverse webs extending from side to side. C. M. S., JR.

106. Paving block. CHARLES L. SULLIVAN and JOHN D. FLETCHER. U. S. 1,422,193, July 11, 1922. A paving block comprising a base and a tread portion, the tread portion being narrower than the base portion and provided with an intervening longitudinally disposed furrow and with central extensions from opposite ends of the block. C. M. S., JR.

107. Brickmaking. GEORGE A. WARNER. U. S. 1,420,796, June 27, 1922. In a molding apparatus for forming bricks or similar articles, the combination of a mold

box provided with a plurality of compartments and having side walls that are corrugated or fluted, and a member having matching corrugations or flutings that can be passed over the mold box to corrugate the plastic bricks. C. M. S., JR.

108. Tile construction. EUGENE CERIAT. U. S. 1,420,020, June 20, 1922. In a tile structure, units having L-shaped cross-section, the longer of the shanks forming the outer and inner surface of the structure, the shorter of the shanks forming the engaging members between the surfaces, the longer shanks having means to engage for forming flush outside surfaces, the shorter shanks having cut-out portions to form horizontal passages in each of the layers of the structure, the shorter shanks being also disposed in spaced relation to one another to form vertical passages for ventilation, reenforcing rods embedded between the several layers in the structure, and other reenforcing rods disposed through the shorter shanks for connecting and reenforcing the structure vertically. C. M. S., JR.

109. Slag-brick machine. CHARLES T. BRAY. U. S. 1,420,018, June 20, 1922 A slag brick machine including a horizontal rotary distributor provided at one end with an opening to receive slag from a furnace and having at the other end a plurality of circumferentially spaced outlets adapted to be successively brought to the bottom of the distributor for discharging the slag, an endless conveyor arranged to carry successively a plurality of molds beneath the discharging outlets, gearing connected with the conveyor and the rotary distributor, a friction disk connected with the gearing for actuating the same, a drive shaft having a flexible coupling, a friction wheel mounted on the drive shaft and arranged to engage the friction disk and adapted to be carried into and out of engagement with the same by the flexing of the drive shaft, means for adjusting the friction wheel, a rock shaft having an arm provided with a bearing receiving the drive shaft, and means for partially rotating the rock shaft to engage the friction wheel and to carry it out of such engagement and to vary the frictional engagement. C. M. S., JR.

110. Interlocking brick. GUY M. BEAN. U. S. 1,420,810, June 27, 1922. A brick having a tapered projection and a correspondingly shaped socket at one face and arranged end to end and located inwardly of the edges of the face of the brick. C. M. S., JR.

111. Brick-scoring mechanism. WILLIAM F. RICHEY. U. S. 1,418,880, June 6, 1922. A mechanism for scoring the faces of bricks or blocks prior to the baking thereof comprising a fixed rest, standards disposed respectively on opposite sides of the rest and interconnected at their upper ends to provide a frame, rotary combs disposed on opposite sides of the rest and between it and the standards, the combs being provided with shafts, brackets in which the shafts of the combs are rotatably mounted, the brackets being provided with threaded shanks extending through longitudinal slots formed in the standards, clamping nuts carried by the threaded shanks and engaging the standards on opposite faces to provide for vertical adjustment of the brackets, a transverse shaft having geared connections with the shafts of the combs, flexible means for imparting rotary motion to the transverse shaft, and adjustable bearing brackets in which the transverse shaft is journaled. C. M. S., JR.

112. Method and means for brick hacking. JAMES B. LADD. U. S. 1,418,658, June 6, 1922. The method of loading and hacking bricks, which consists in the following steps, moving bricks in the direction of their length, bringing the bricks to rest abutted end to end in rows greater in length than a car, assembling the rows in parallel relationship, sufficient in number to form a layer the full width of the car, and transferring to the car at one operation such part of the assembled rows as shall form a complete layer for the car. C. M. S., JR.

113. Tile for floor structures. JULIUS H. TOUPET. U. S. reissue 115,369, May 30, 1922. In a building structure, a hollow tile having a top wall consisting of an arched

span increased in thickness from its center towards each side, whereby pressure thereon will be converted into lateral thrust and grooves extending through the exterior faces of the side walls into the thickened portions of the arched span. C. M. S., JR.

114. Apparatus for molding hollow bodies. PERCY A. E. ARMSTRONG. U. S. 1,416,927, May 23, 1922. Apparatus for casting hollow bodies, comprising a mechanically strong core center and a plurality of collapsible mold core sections centered directly upon and supported by the member. C. M. S., JR.

115. Process and machine for making bricks. WILLIAM H. HAWS. U. S. 1,425,010, Aug. 8, 1922. The process of molding bricks from brick forming material, which consists in supplying a mold with an excess of material, compressing portions of the material near the walls of the mold with greater force than the material removed from the walls, while relieving pressure on the last mentioned portion of the material, then finally compressing all the material. C. M. S., JR.

116. Interlocking tile. FRANK DOCHNAL. U. S. 1,425,181, Aug. 8, 1922. An interlocking tile comprising a perforated body having its inner face provided with three facial ribs, the intermediate rib extending beyond the plane of the other two ribs. C. M. S., JR.

117. Brick cleaning machine. SAMUEL M. FUNK. U. S. 1,424,719, Aug. 1, 1922. A cleaning machine including conveyors alongside of one another, cleaning surfaces at opposite sides of one of the conveyors, an abutment element beyond the cleaning surfaces for guiding the articles to be cleaned on to the second of the conveyors and turning the articles over upon a cleaned side, and a second set of cleaning surfaces at opposite sides of the second conveyor beyond the abutment element. C. M. S., JR.

118. Superlocking hollow tile. OTIS V. NEESE, FLO L. NEESE and EARL C. NEESE. U. S. 1,424,372, Aug. 1, 1922. A superlocking hollow tile block comprising a pair of equal-sized hollow sections, one section extending beyond one end and the side adjoining that end of the remaining section, the sections having interposed thickened walls for spacing the sections apart, and the walls extending and being reduced beyond the overlapped portions of the two sections, the reduced portions of the walls being integral with the opposite sections at opposite ends of the block. C. M. S., JR.

119. Brick. JOHN EDWARD EVANS. U. S. 1,422,949, July 18, 1922. A brick comprising a body portion, a flange on the inner edge of a side of the body portion, a recess formed on the inner edge of the opposite side of the body portion adapted to receive the aforementioned flange of a contiguous brick in a structure, a groove formed in the periphery of the body portion on one of the sides, a wedging tongue on the periphery of the opposite side adapted to be received in the aforementioned groove of a contiguous brick in a structure, the flange being provided with an opening to receive a nail or other fastening extending diagonally therethrough in the general direction of the side of the brick remote from the flange. C. M. S., JR.

Glass

120. Some properties of lime-magnesia glasses and their commercial application. II. S. ENGLISH AND W. E. S. TURNER. *J. Soc. Glass Tech.*, **20**, 357–63(1921).—*The annealing temp. and expansion coeff.* of the series of glasses described in Part I, are given. The annealing temp. for the lime-magnesia glasses is considerably lower than for the corresponding glasses contg. only lime or magnesia. The coeff. of expansion decreases continuously from 8.44 to 7.54 $\times 10^{-6}$ as CaO is replaced by MgO. The advantage of the addition of MgO to the batch was now clear. Possible cheap commercial sources of magnesia are discussed. The probable advantage of adding small amounts of alumina to the lime-magnesia batch was suggested. G. S. FULCHER

121. Measurement of small variations of refractive index throughout meltings of optical glass. A. J. DALLADAY AND F. TWYMAN. *J. Soc. Glass Tech.*, **20,** 325–30 (1921).—To test the homogeneity of a melt, a number of samples, about $^1/_{10}$″ thick, were polished flat, placed in optical contact, heated until they became a solid block, and then ground and polished perpendicular to the plane of the samples. When such a composite block is placed in the path of one of the beams of a Michelson interferometer, the central black band will be shifted different amts. by the different samples if they are not of the same index of refraction. Differences of one in the sixth decimal place can thus be readily measured. Results of some tests are given. G. S. FULCHER

122. A suggested method for the determination of the absolute viscosity of molten glass. IRVINE MASSON, L. F. GILBERT AND H. BUCKLEY. *J. Soc. Glass Tech.*, **20,** 337–41(1921).—If the rate of fall of a metal ball were detd. by taking a series of X-ray photographs, the viscosity could be computed from Stoke's equation as corrected by Ladenburg. The method was tested with glycerine syrups and results accurate to about 1% were obtained. By making measurements with balls of different d., such as platinum and nickel, the *d. of the glass* could also be detd. The method is obviously not applicable to lead glasses. G. S. FULCHER

123. The relative advantages and disadvantages of limestone, burnt lime, and slaked lime as constituents of common glass batches containing soda-ash and salt-cake. ANON. *J. Soc. Glass Tech.*, **20,** 341–5(1921).—*Discussion* of article by F. W. Hodkin and W. E. S. Turner in same journal, p. 188. G. S. FULCHER

124. Some properties of lime-magnesia glasses and their commercial application. I. VIOLET DIMBLEBY, F. W. HODKIN AND W. E. S. TURNER. *J. Soc. Glass Tech.*, **20,** 352–7(1921).—*The melting and lamp working properties* of a series of 7 soda glasses with mol. compn. 6 SiO_2, 1.2 Na_2O, 0.8(CaO + MgO), in which the MgO content was varied up to 6.5% and the CaO content decreased, correspondingly, from 9.2 to 0%. It was found that as the CaO is replaced by MgO, readier melting, easier working and less devitrification is obtained up to 2.6% MgO, but with 3.6% or more MgO, the glass is less easy to melt and to work than the pure soda-lime glass. G. S. FULCHER

125. The effect of the rays from radium, X-rays and ultra-violet rays on glass. J. R. CLARKE. *J. Soc. Glass Tech.*, **5,** 155–65(1921).—Results previously obtained by Doelter and others for various glasses and allied substances are summarized. In order to ascertain the *effect of selenium and cobalt oxide on the coloration of soda-lime glasses*, 3 glasses contg. up to 0.13% of selenium and three with up to 0.004% cobalt oxide were exposed to the various radiations. X-rays, ultra-violet rays and γ-rays produced no effect with the exposures tried but β-rays colored the glasses brown, to a depth equal to the range of the rays. With prolonged exposure the coloration increased to a max. which was darker the greater the amt. of coloring agent present, and then remained constant. The pure soda-lime glass was not affected by the β-rays but was slightly colored on the surface by the α-rays. All the glasses showed *fluorescence*, due chiefly to the α-rays, but the colored glasses alone showed a marked fatigue effect after reaching maximum coloration. All the glasses after exposure to the emanation showed *thermo-luminescence* with disappearance of color after longer or shorter heating at 100°, 160° and 235°. It is believed that the coloring of the glasses is due to the formation of colloidal particles, perhaps by the action of the rays on dissociated ions present in the glass. H. P. HOOD

126. On the quantitative study of technical problems in the glass industry. M. W. TRAVERS. *J. Soc. Glass Tech.*, **5,** 124–33(1921).—Presidential address. A plea for well-planned research and quantitative methods of attacking problems relating to the glass house. H. P. HOOD

127. The thermal expansion of glasses containing aluminium. S. ENGLISH AND

W. E. S. TURNER. *J. Soc. Glass Tech.*, **5**, 183–7(1921).—Soda and soda-lime glasses contg. considerable propns. of aluminium have comparatively low thermal expansions. On the basis of mol. compn. Al_2O_3 reduces the expansion most, MgO less, and CaO least of the 3 oxides, when substituted for soda in tri-silicate glasses. On the basis of wt., however, MgO has much the greatest effect, lime and alumina being of about equal value. Owing to the acidic properties assumed by Al_2O_3 at times it is pointed out that it may not substitute sodium oxide in exactly the same way as calcium or magnesium oxide. H. P. HOOD

128. The relative advantages and disadvantages of limestone, burnt lime, and slaked lime as constituents of common glass batches containing soda-ash and salt cake. I. F. W. HODKIN AND W. E. S. TURNER. *J. Soc. Glass Tech.*, **5**, 188–94 (1921).—Limestone is the cheapest of the three and affords mechanical stirring during glass melting. Limes are unpleasant to handle and change in wt. due to absorption of various amts. of moisture and CO_2. A number of crucible melts were made to det. effect on rate of melting and on the fluidity of the resultant glasses of corresponding amts. of limestone, burnt lime and slaked lime. The source of soda was also changed to det. the effect of using soda-ash, soda cake or mixt. of the two. A batch composed of soda-ash and burnt lime melted in all cases faster than any other combination while at corresponding temps. it was also the most fluid. With soda-ash, slaked lime offers a higher melting rate than limestone, while with soda cake limestone gives the higher rate. Glasses contg. salt cake and burnt lime are generally more viscous and melt the slowest. Between the three batch mixts., soda-ash-limestone, soda-ash-salt cake-limestone, and soda-ash-salt cake-lime there is less marked difference. The relative advantages offered by the three forms of lime may be markedly changed by changing the source of alkali, soda-ash or soda cake. Glasses made from soda cake alone tend to carry a slight scum. Soda cake or mixts. of the two sodas produced no such result. H. P. HOOD

129. The effect of the joint presence of sodium and potassium on the solubility of lead glasses. The development of various types of glass. XI. C. J. PEDDLE. *J. Soc. Glass Tech.*, **5**, 195–201(1921).—It is found that the maximum durability in an alkali-lead silicate glass is obtained when the alkalies K_2O and Na_2O are mixed in the ratio of 7 to 3, and that the ratio holds good for all percentages of alkali below 20 and is furthermore independent of the amt. of SiO_2 or PbO in the glass. The substitution of PbO for SiO_2 improves the durability when the PbO is under 50%. In the alkali-RO-SiO_2 glasses where RO represents CaO, PbO, BaO, SrO, ZnO or MgO, when the total alkali present is less than 20%, the glass contg. both alkalies in equal propns. by wt. will be less sol. than either the glass contg. all its alkali as K_2O or all as Na_2O. Cf. *Ceram. Abs.*, **1**, 20, 81, 165–66(1922). H. P. HOOD

130. Durability of optical glasses. Report on an investigation on the determination of the durability of optical glasses. T. HAIGH. 51 pp. Pub. by British Scientific Research Association, London. Oct., **1921.**—Systematic study of tests used to determine durability and estimation of alkalinity, by the iodeosin reaction. Values of freshly fractured and weathered surfaces. Investigation of polished surfaces. Changes in the alkalinity of fractured surfaces with variations in the conditions of weathering. Influence of chem. compn. on the alkalinity of the surfaces. Durability as detd. from a visual examn. of the polished surfaces after autoclaving. Alkalinity of aqueous extracts of the glasses after autoclaving. Alkalinity of glass surfaces after autoclaving in steam. The dimming test. Retention of moisture by the glasses in the powdered form. Summary and microphotographs of "weathered surfaces." W. M. CLARK

131. American factory successfully makes 40-inch telescope disc. ANON. *Glass Worker*, **41**, No. 45, 9, 29–30(1922).—The optical department of the Spencer Lens Co.

has completed the largest disc ever made in the U. S. This disc is 8 inches thick, weighs 900 lbs., and will be a part of the first all-American telescope. The glass is a borosilicate crown of low coeff. of expansion. Its compn. is SiO_2 70.8, K_2O 14.4, Na_2O 5.4, CaO 2.0, B_2O_3 7.2, As_2O_3 0.2. J. B. PATCH (*C. A.*)

132. The effect of absorbed gas on the conductivity of glass. V. BUSH AND L. H. CONNELL, JR. *Franklin Institute*, **194** [2], 231(1922).—Results show that gases in particular water vapor, penetrate throughout the vol. of glass and quartz and radically affect their vol. conductivity. Vol. resistivity of Corning G-702 glass was increased 6 times when heated in a vacuum. On exposure to air, resistivity decreased slowly but did not return to the original value. Pyrex glass and quartz was also tested showing similar results. R. J. MONTGOMERY

133. Making white flint glass in a tank furnace. F. W. ADAMS. *The Glass Worker*, **41** [50], 11(1922); *Pottery Gazette.*—Colorless glass to replace pale green glass requires purer materials. General discussion of tank, tank block, batch, decolorizers and annealing is given. R. J. MONTGOMERY

134. Note on the composition, or the comparative composition, of glasshouse pots made in the last fifty years. G. V. EVERS. *J. Soc. Glass Tech.*, **20**, 330–7(1921).—Some pieces of pot made by E. J. and J. Pearson of Stourbridge in 1868 and 1887 had come to light and had been compared with a pot made in 1921. The silica and alumina in the 1921 pot run 60 and 26% instead of 65 and 23% in the older pots, and though the alkali is somewhat higher, the refractory standard is, if anything, higher, and the porosity somewhat less. The importance of coöperation between the makers and users of pots in keeping accurate records of performance and properties is emphasized. G. S. FULCHER

135. Specifications for lime-flint glass tumblers. ANON. Bur. of Standards, *Circ.* **119.**—Specifications are given for a plain pressed hotel tumbler made of lime-flint glass. The items include the designation, measurements, material, quality, tolerance in size and weight, shock test, boiling test, acceptance, and sampling. They were formulated under the auspices of the Bureau of Standards and have been accepted by the Army, Navy and Marine Corps, Public Health Service, and General Supply Committee of the United States Government. At least 95% of the samples must pass all tests. The tests include 5 fillings with boiling water with sample at room temperature at the start (the shock test); and boiling for 6 hrs. to disclose any sign of corrosion, scumming, chipping or cracking (boiling test). Traces of color or bubbles if not unsightly are allowed but there must be no stones, cords, nor fine cracks. The dimensions, wt., and capacity, are specified with the min. and max. allowable for each. H. F. S.

136. Specifications for glass refractory materials. W. J. REES. *Jour. Soc. Glass Tech.*, **6**, 181(1922).—This is a critical review of the Provisional Specifications which were proposed about three years ago, by a Comm. of the Soc. of Glass Tech., after a consultation with representative manufacturers of refractory materials for the glass industry nominated by the Employers' National Council for the Clay Industries. Though these specifications have been used but little it will be generally agreed that the proposed specifications for silica bricks and blocks which have been made to comply with the specifications have given excellent results in practice. Sp. gr. of bricks; bonding ingredients and powder density; expansion; and mech. strength are discussed; also storage of refractories. Specifications for tank-blocks are dealt with at length. Specifications for pot clays are even more debatable than in the case of silica bricks and tank-blocks. Much discussion has taken place as to the relative merits of siliceous and aluminous clays for potmaking, but the factors other than chem. compn. of the clay which affect the durability of the pot may obscure the real issue. Two important properties of aluminous clays must receive consideration in connection with their use for

pot-making: their great contraction at high temp. and their low mech. strength at high temp., the latter factor causing bulging and often collapse of the pot. Siliceous clays have a much smaller contraction than aluminous clays, and pots made from them have a greater mech. strength at high temp. The maturing of pot clay and the drying of pots are two subjects on which extended investigation is desirable. Information is also required as to the relative thermal conductivities at glass-founding temp. of the various types of siliceous and aluminous clays. Progress in the production of pot clays is essential to the development of the glass industry. O. P. R. O.

137. Lime specifications for glass manufacture. R. R. SHIVELY. *Chem. Age* (N. Y.), **30,** 296; *Glass Industry,* **3,** 154–6(1922); cf. *C. A.*, **16,** 1139.—These specifications vary but little from those recently published. The quantity of Fe_2O_3 should be as low as possible, the general range being from 0.1% to 0.8% and should not vary more than 0.1% in various shipments. The Al_2O_3 and SiO_2 content is not objectionable but when once established the Al_2O_3 should not vary more than 0.5%, and the SiO_2 not more than 1% from the established compn. Fineness is an important factor governed entirely by local requirements. In large tanks coarse stone is preferred. If the tank is being worked to capacity it is believed that fine stone increases production. Unless otherwise specified all limestone and quicklime should pass a 20-mesh sieve. Lime causes 90% of the troubles in glassmaking arising from the batch materials, but much of the trouble commonly attributed to batch materials comes from other sources. J. B. PATCH (*C. A.*)

138. Optical problems in glassmaking. H. P. GAGE. *Phys. Rev.*, **15,** 247–8 (1920).—The phys. properties of glass are of the highest importance. The danger of unsuitable design of glass is illustrated by the use of curved instead of flat colored roundels in railway signals, thus obviating the possibility of an obscuring reflection produced by the powerful beams of elec. headlamps. The production of glasses possessing selective absorption and transmission of various wave lengths of light is of increasing importance. Demonstration of ultra-violet transmission and absorption of various glasses can be readily made with the aid of the fluorescence of an anthracene coated screen and the infra-red transmission by the ignition of ordinary typewriter carbon paper. J. B. PATCH (*C. A.*)

139. The coloration of glass by ultra-violet light. J. B. NATHANSON. *Phys. Rev.*, **17,** 408–9(1921).—A new type of glass was produced which when used for 400 hours as a globe for a Hg arc operating at about 87 watts showed no trace of coloration. An old type of glass similarly used developed a distinct purple color. J. B. P. (*C. A.*)

140. Glass technology. G. W. MOREY. *J. Ind. Eng. Chem.*, **14,** 823–4(1922).—Prominent among the recent advances in the glass industry are the improvements in the knowledge and technic of glass annealing, the studies of the relation of the phys. properties of glass to its chem. constitution, and the continued extension of the use of glass feeders and automatic machinery. Also noteworthy are the appearance of two new glass publications and the growth of the glass section of the Am. Ceramic Society. J. B. PATCH (*C. A.*)

141. The movement of molten glass in pots. H. W. HESS. *Glass Worker,* **41** [40], 11(1922).—During the melting of a filling of batch and cullet there is a positive motion of the mass after fusion has proceeded to a certain extent, much the same as the water in a boiler flows in a positive direction, due to the point of max. heating and the evolution of gases. Unequal heating of the pot may cause a circulation of glass which has been contaminated by the pot clay and thus spoil the melt. J. B. PATCH (*C. A.*)

142. Pyrex glass. OSKAR LECHER. *Chem.-Ztg.*, **46,** 469–70(1922).—An analysis is given as follows: SiO_2 80.71, B_2O_3 10.47, Al_2O_3 3.55, CaO 0.70, MgO 0.57, Na_2O 4.14. A similarity is claimed to the German glass 59 III. J. B. PATCH (*C. A.*)

143. The decomposition of the glass of ancient windows in the church of Thann. M. BATTEGAY, G. HUGEL AND TH. VOLTZ. *Bull. soc. ind. Mulhouse*, **88**, 27–30(1922).—The glass consisted of a white and a red layer, the outer surface of the latter being covered with small, whitish, irregular cavities. The white substance in the cavities was shown to be $CaCO_3$ resulting from the slow decompn. of the glass under the action of light and humidity. The glass contained only 65.5% SiO_2. The alky. of the glass decreased its stability and the oxides (of Fe, Al, Cu, Mn, and Zn) which colored it acted as catalyzers to hasten the decompn. A. P.-C. (*C. A.*)

PATENTS

144. Machine for grinding beveled rim surfaces on spectacle glasses. OTTO HENKER. Germany. 1,422,055, July 4, 1922. In a machine for grinding beveled rim surfaces on spectacle glasses, a grindstone, a shaft rotatably disposed in a body and adapted to hold a spectacle glass, guiding means allowing to displace during the grinding operation the grindstone and the shaft relatively to one another, these guiding means forming with the shaft an angle which differs from 90°, and a cam coacting with a stop for limiting the relative displacement of the grindstone and the shaft, the angle contained by the stop and the guiding means being variable. Cf. *Ceram. Abs.*, **1**, 189(1922). C. M. S., JR.

145. Method of producing nonshatterable glass. OTTO S. MARCKWORTH. U. S. 1,421,974, July 4, 1922. A method of producing nonshatterable glass comprising immersing assembled glass and celluloid laminae in a solution consisting of fusel oil, camphor and methyl salicylate while the solution is at a temperature between 24 degrees and 35 °C, subsequently raising the temperature of the solution which has been applied to the laminae, applying pressure to the laminae, and subjecting the parts to a progressively increasing temperature during the pressure. C. M. S., JR.

146. Closure for molten glass-outlets. VERGIL MULHOLLAND. U. S. 1,421,810, July 4, 1922. An insulating closure for the discharge outlet of a container for molten glass, comprising a holder provided with heat insulating material adapted to close the outlet, means for positioning the closure relative to the outlet, and means for yieldingly holding the closure against the outlet. C. M. S., JR.

147. Method and apparatus for producing sheet-glass. JOSEPH E. CROWLEY and CLIFFORD A. ROWLEY. U. S. 1,422,036, July 4, 1922. In an apparatus for continuously producing sheet glass, a source of molten glass, a pair of horizontal cylindrical metallic rollers having their cylindrical surfaces tinned, means for adjusting the rollers vertically, toward and from each other, means for internally cooling the rollers, means for rotating the rollers in opposite directions, a receptacle containing molten tin in which the lower portion of each roller revolves, means for flowing molten glass from the source into the trough between the rollers, the glass flowing through the slot formed by the contiguous surfaces of the rollers and emerging in the form of a downwardly moving sheet of glass, a heated chamber in which the rollers are located, having a slot in its lower side, and means for cooling the sheet as it emerges from the chamber. C. M. S., JR.

148. Method and apparatus for the manufacture of glass. ROBERT GOOD. U. S. 1,421,210, June 27, 1922. The method of melting glass-making material which comprises introducing the material into a melting tank wherein the material is fed vertically down through the tank in a receptacle of conical shape, wherein by reason of the lessening diameter of the receptacle the material is subjected to an increasing temperature until fusion is effected and the material runs by gravity into the bath in the tank. C. M. S., JR.

149. Sheet-glass-drawing apparatus and method for drawing glass. JOHN R. SCOHY. U. S. 1,420,868, June 27, 1922. The method of drawing sheet glass which

consists in drawing the glass substantially vertical in sheet form and maintaining the edges of the sheet substantially in parallel relation by feeding the glass to the edges through slotted bodies, turning the glass over a member, shearing the turned portion of the glass at a point near the member, and raising the member and the glass to form a succeeding sheet. C. M. S., Jr.

150. Automatic electric heating device for glass furnaces. Walter G. Clark. U. S. 1,420,181, June 20, 1922. An electrically operated heating device consisting of a multiple of heating units arranged in close proximity to the sheet of glass between the tank and the first supporting roller on a continuous window glass-making apparatus, together with a thermostat for automatically determining the amount of energy required in order to maintain the glass sheet at the proper degree of plasticity for successful operation, and means for removing and replacing the heating elements without interrupting the operation of the glass-making apparatus. C. M. S., Jr.

151. Glass cutter. Henry A. Ryther. U. S. 1,419,310, June 13, 1922. In a turret glass cutter which includes a turret-holder composed of a pair of spaced apart jaws and a clamping screw; a relatively thick wheel-carrying turret having counterbored cavities in one side intersecting the periphery of the turret so that each cavity has a mouth on the periphery, and integral studs located in the cavities, and supporting the usual glass-cutting wheels, the cavities being formed to protect the major portions of the wheels, and to permit other portions to project outward from the periphery of the turret, the thickness of the turret conforming to the space between the jaws, so that each side of the turret contacts with one of the jaws. C. M. S., Jr.

152. Apparatus for gathering glass from a molten mass Alfred C. Pilkington and Joseph Gaskill. England. 1,417,684, May 30, 1922. In apparatus for gathering glass, of the pipette type, an obturator adapted to contain a small quantity of glass, means operative to slide the obturator over the mouth of the pipette to open it, and an inner back edge on the obturator adapted, on so sliding the latter, to shear off from the glass in the mouth of the pipette, the small quantity of glass in the obturator. C. M. S., Jr.

153. Method of and apparatus for drawing glass. Clarence P. Byrnes. U. S. 1,425,746, Aug. 15, 1922. In the drawing of hollow glass articles from a tank or forehearth, the steps consisting in feeding air upwardly through the bath, baffling the air to retain distending pressure for the hollow glass body, while allowing baffled air to pass upwardly from within a floating ring by engaging its sides to continuously lift it. C. M. S., Jr.

154. Plate-glass annealing leer. Edwin E. Milner and William J. Lytle. U. S. 1,426,310, Aug. 15, 1922. A plate glass annealing leer having a plurality of muffle heating chambers arranged zig-zag with respect to each other, a plurality of heating flues in the top wall of each of the chambers, means for producing combustion for each of the flues, means common to all of the combustion-producing means in the side wall of each of the chambers, offtake means for each of the flues, and means for connecting all of the offtakes together. C. M. S., Jr.

155. Rotary glass cutter. Carl F. Doerr. U. S. 1,421,921, July 4, 1922. In a rotary glass cutter, a cutter bar, a sleeve adjustably fastened to the cutter bar, a cutter head provided with cutters arranged in spaced relation and projecting from the peripheral face of the cutter head, the latter being mounted to turn on and to slide on the sleeve to allow of adjusting the cutter head on the sleeve, and means securing the adjusted cutter head in place on the sleeve. C. M. S., Jr.

156. Rotary glass cutter. Carl F. Doerr. U. S. 1,424,625, Aug. 1, 1922. In a cutting implement having a plurality of cutters adapted to be brought selectively into cutting relation, embodying a cutter bar, a carrier sleeve longitudinally adjustable

thereon, a stationary abutment at one extremity thereof, an axially movable abutment thereon, a cutter head mounted for axial and rotary movement on the sleeve between the abutments having circumferentially spaced cutters projecting from the periphery thereof, and interengageable means on the confronting faces of the stationary abutment and the cutter head adapted to lock the elements against relative axial and rotary movement upon clamping engagement of the cutter head between the stationary and movable abutments. C. M. S., JR.

157. Gauge glass. JOHN H. HANLON and WM. J. HANLON. U. S. 1,424,642, Aug. 1, 1922. In a water gauge for boilers the combination of a body having an opaque rear face and a sight opening closed by a cylindrical glass, the interior face of which is furnished with a plurality of projections disposed in a plurality of concentric circles, the projections being also disposed in such manner that they avoid straight line rows in any direction. C. M. S., JR.

158. Obtaining glass. JESSE M. SAID. U. S. 1,424,184, Aug. 1, 1922. In apparatus for delivering molten glass, the combination of a ladle mounted on a horizontal axis over a pool of glass, means for imparting movement to the ladle on its axis to cause it to enter the glass and obtain a quantity thereof, means for swinging the axis of the ladle to cause the ladle to clear the pool, means for inverting the ladle so as to discharge a quantity of glass therefrom, and means for returning the ladle to its position over the pool. C. M. S., JR.

159. Manufacture of sheet glass. HENRY F. CLARK. U. S. 1,424,155, Aug. 1, 1922. The method of drawing glass sheets, consisting in drawing a sheet upwardly in a generally vertical direction, bending it over a bending device and moving it in a generally horizontal direction, and subjecting the lower surface of the sheet after it passes the bending device to the action of a heated jet. C. M. S., JR.

160. Means for controlling discharge from glass tanks. EDWARD S. HUTTON. U. S. 1,423,220, July 18, 1922. The combination of a glass tank and a discharge spout, with a wall between the lower part of the spout and the glass tank and an opening above the wall for the flow of glass from the tank to the spout, a floating block inside the glass tank with a transversely disposed passageway in the block arranged so that when the block is in one position against the wall, the passageway will extend from the lower part of the block to a point higher than the wall and permit the flow of the glass from the tank to the spout, and when the block is turned over will prevent such flow of glass C. M. S., JR.

161. Sheet-glass drawing machine. ORA M. COX and CONNIE C. ROSE. U. S. 1,423,195, July 18, 1922. In a sheet glass drawing machine, a frame, a pair of spaced guides located at the opposite sides of the frame, superposed blocks slidably mounted in the guides, worm wheels rotatably carried by the frame, rotatable vertical shafts arranged in opposite sides of the frame, worms keyed to the shaft and meshing with the wheels, means for connecting the shafts together for synchronous movement, connecting rods operatively connected to the worm wheels and to the sliding blocks, movable arms carried by the sliding blocks, crank arms pivotally carried by the sliding block and connected to the movable clamping arm. C. M. S., JR.

Enamels

PATENTS

162. Method of producing and applying enamel coatings to metallic surfaces. HERBERT M. SMITH. U. S. 1,425,612, Aug. 15, 1922. As a part of the process of enameling, applying an enamel mixture to a surface which is to be coated, thereby distributing the material over the surface, subjecting it to a fusion temperature and air blast thereto while the fusion is going on. C. M. S., JR.

163. Method or process of removing enamel from enameled metal articles. WILLIAM E. PATCH. U. S. 1,416,865, May 23, 1922. The method of de-enameling enameled metal articles which consists in subjecting the article in a closed oven to a temperature above the original baking temperature. C. M. S., JR.

Cement, Lime and Plaster

164. Burning cement in two stages. C. DIDIER. *Brick Pot. Trade Jour.*, **30**, 205–6(1922).—In the first stage the cement is fired at 1000°C at which temp. the $CaCO_3$ is dissociated. It is then slaked with water and the impure portions removed by screening. This screened portion is then fired at a higher temp. which forms the sinter. Because of the increased cost of this process it is necessary to increase the selling price of this product over that made with one burning stage. H. G. SCHURECHT

165. Mineral resources of Guatemala. ANON. *Jour. Royal Soc. Arts* (London), **67**, 633(1919).—Limestone is found in great quantities throughout Guatemala. A siliceous volcanic ash is frequently found with the limestone, which can be roasted with the lime for the production of cement, resulting in a good grade product. Graphite and mica also occur in several places. A good grade of marble has been found in very large quantities. There are several salt springs. Large amts. of sulphur are brought to the market by the Indians, who extract the sulphur from the numerous vol. craters. Niter-bearing ground is found in numerous regions. Prospecting presents unusual difficulties because of the thick vegetation and the heavy volcanic ash, both of which hide the rock. With improved shipping facilities it may prove financially worth while to undertake the exploitation of several of these minerals. O. P. R. O.

166. A "blackboard" of soot and cement. ANON. *S. African Jour. Ind.*, **5**, 306(1922).—A new blackboard was constructed on a stone wall thoroughly cleaned, the joints were well raked out and wetted, and the first coat of cement plaster applied, consisting of 4 sand, 1 cement. A second coat of 3 to 1 and finished with a thin layer ($^1/_8$" thick) of neat cement and mineral black (soot from engine smoke-box) in the proportions of 1 bucket of cement to $^1/_4$ bucket soot, well mixed. The surface kept moist for a few days to prevent too rapid external drying. The result has been satisfactory, the blackboard being superior to the ordinary ones, less chalk being used and consequently less chalk dust being produced. A dead finish is obtained, making the writing on the blackboard easily seen from any angle. The soot does not stain the hands when the blackboard is being used. O. P. R. O.

167. Water tightness of concrete structures. H. C. RITCHIE. *Canadian Engineer*, **43**, 355(1922).—An interesting discussion of the whole question of concrete for water-holding structures read recently before the Institution of Water Engineers (London). A greater consideration of the tensile stresses in the concrete is urged. R. would limit the tensile stresses in the reinforcement steel to from 9,000 to 12,000 lb. per sq. in., depending upon the quality of the concrete, the percentage of reinforcement and the head of water on the structure being designed. He recommends that the direct tensile stress should not be allowed to exceed 10% of the ultimate compressive resistance of the concrete at 30 days. He advocates the deliberate localization of cracks through the placing of expansion joints at suitable places, particularly at planes of stoppage between successive day's work. The max. distance apart of these joints suggested is 25 to 30 ft. The advantage of complete sepn. of the bottom of a circular tank from the wall is also pointed out. By this device the restraining moment set up in the structure at the bottom of the wall is completely overcome, while at the same time there is no difficulty involved in making the structure water-tight. Such construction has been adopted with success in America with some comparatively large tanks. O. P. R. O.

168. Electric cement. ANON. *Times Trade Supplement*, **10,** 493(1922).—The new cement now known as "elec. cement" is manufd. by a process different from that adopted by the Lafarge Co. in the production of their "aluminous cement." The latter is made by a water-jacket process, while the elec. cement is produced by fusion of the raw materials in an elec. furnace. The main reason for the adoption of elec. was the high price of coal. The product has many advantages over ordinary Portland cement. The most noteworthy claims made for it are: (1) although slowsetting it hardens rapidly; its strength after 24 hrs. equals that of Portland cement after 28 days; (2) its ultimate strength being much greater than that of Portland cement, the safe working stresses can be increased to 3 times those now generally adopted; (3) it resists absolutely the action of sea water. These advantages are of sufficient importance to outweigh the higher cost of the material. Elec. cement cannot be used mixed with other varieties of cement or lime and great care must be taken when mixing it to see that all utensils have been thoroughly cleansed, so that no trace of lime or cement other than elec. cement remains in them. O. P. R. O.

169. High alumina cements. ANON. *Engineering* (London), **114,** 180(1922).—Experiments to find some binding material which would withstand the destructive action of sulphates in earths and water, on lime mortars and ordinary cements have resulted in producing high alumina cements, differing from Portland cement by valuable properties. Working on lines suggested by M. Vicat's conclusion that a cement for which the ratio (silica + alumina) : (lime + magnesia) is greater than 1, will resist the action of sea water, M. J. Bied began exptl. work with a view to increasing this ratio by raising the propn. of alumina. There are 4 aluminates of lime: $3CaO, Al_2O_3$; $5CaO\ 3Al_2O_3$; CaO, Al_2O_3; and $3CaO, 5Al_2O_3$. The first two of these are of little practical value owing to their extremely rapid setting in contact with water, but the last are valuable either pure or in the form of mixt. and in connection with these that the work has resulted in material of practical utility. In France the materials employed consist of bauxite, schist, limestone and slag. These ingredients are mixed, the mixt. is then melted in the cupola or elec. furnace, run off, cooled and reduced to powder. Normal analysis of the product shows about the following: silica, 10 to 12; alumina, 40 to 45; iron or oxide of iron, 10 to 20; lime, 35 to 40. The resulting material has properties differing in a marked degree from Portland cement. (1) The material does not decompose under the action of sea water, or in contact with earths or water contg. sulphates. (2) The material is slow setting, this action not commencing from 2 to 4 hrs. after mixing, so that ample time is secured for pouring and handling, and the adjustment of reinforcing bars. (3) The cement hardens so rapidly that at the end of a few hrs. the strength exceeds that of Portland cement after several weeks. Setting is accompanied by a considerable rise of temp., up to 175°C shortly after setting, while the action is said to proceed from the interior outwards. As typical of tests showing the characteristics of alumina cements we may give the following: in tests of pure cement of this class, with the standard test-piece a tensile strength of 33 kg. was obtained at 24 hrs., 59 kg. at 48 hrs., 64 kg. at 72 hrs., 67 kg. at 7 d$_s$, and 71 kg. in 28 days. A first-class Portland cement gave comparative figures of 10 kg., 22.5 kg., 33 kg., 50 kg., and 55.5 kg. respectively. A 1 : 3 mortar of high alumina cement gave, for similar periods, 29 kg., 34 kg., 35 kg., 36 kg., and 38 kg., the corresponding Portland cement mortar tests showing only 3 kg., 7.5 kg., 11 kg., 19.5 kg., and 27.5 kg. For concrete the superiority of the alumina cements is equally good, if not better than is shown by the above tests. For compression tests the results are even more interesting. In this case a block of neat alumina cement gave 470 kg. per sq. cm. at 24 hrs., 687 kg. at 48 hrs., 743 kg. at 72 hrs., 815 kg. at 7 days, and 959 kg. at 28 days compared with 70 kg., 141 kg., 264 kg., 456 kg., and 612 kg. for neat Portland cement. In the 1 : 3 mortar alumina cement

gave in compression 352 kg., 387 kg., 400 kg., 431 kg., and 475 kg., while Portland cement showed only 18 kg., 55 kg., 84 kg., 164 kg., and 287 kg. for similar periods. The increased strength of high alumina cements is thus very marked. On the Northern Railway of France these cements have been used for concrete buildings. No trouble has been found in effecting sound joints between new and old work. In the manuf. of concrete pipes, a repetition job, the fol. advantages have been found: (1) a reduction in forms, and increase of output, (2) a weaker mixt. has been possible with reduced thickness and less reinforcing, resulting in reduced finished wt. Pipes have been delivered and laid the day after pouring. For transmission line standards similar savings in time and wt. have been secured, where these standards have to be transported for erection into the heart of mountainous districts. The quick hardening properties make concretes of these cements suitable for pre-cast work, while pre-cast elements of ordinary reinforced concrete have been joined together in position with high alumina cements with success even in the case of tension members. This cement made it possible in a bank to convert rapidly a complete floor of small rooms into a series of halls with large clear floor spaces, and considerable spans. Spans of 18 m. were introduced without difficulty, though it would have been impossible to bring into the building and manoeuver into place girders of that length. Further, Portland cement reinforced concrete would have involved obstruction of the normal work too long a period. In this case the forms were removed in 48 hrs., and the whole job completed without interfering with office work on the 3 floors above. In districts where power is cheap the elec. fusion method of production has advantages. In many cases the overall savings have been well established, while the economy in time is often the detg. factor in the situation.

O. P. R. O.

170. Alumina cement, its development, use and manufacture. H. S. SPACKMAN. *Eng. News-Record*, **88,** 831–4(1922).—S. discusses the properties and use of high alumina cement as manufactured in France. J. C. WITT (*C. A.*)

171. Heat distribution in burning cement clinker. E. H. WHITLOCK AND C. E. BURGOON. *Concrete* (Cement Mill Section), **20,** 87–94(1922).—The authors studied the operation of a cement kiln by taking the temps. at various stations by pyrometers, measuring the draft, and analyzing the kiln gases and samples of the raw mix taken at various points in the kiln. They obtained some interesting data on the heat required for the various reactions taking place. They are of the opinion that it is possible to design a burner that would result in a saving of at least 25% of the coal now required.

J. C. WITT (*C. A.*)

172. Segregation as it applies to tanks as segregating or mixing devices. CHARLES CATLETT. *Concrete* (Cement Mill Section), **20,** 95–100(1922).—C. points out the importance of segregation in many mfg. processes and discusses some of the factors which influence it. He applies the results of his expts. particularly to the manuf. of cement and points out a no. of points at which segregation may be greatly diminished by the application of several elementary principles. J. C. WITT (*C. A.*)

173. Excess air in cement kilns. C. O. SANDSTROM. *Concrete* (Cement Mill Section), **20,** 112(1922).—S. discusses the quantity of air necessary for a cement kiln and states that he believes many kilns are operated with too much draft.

J. C. WITT (*C. A.*)

174. Asano Portland Cement Company of Japan. P. C. VAN ZANDT. *Concrete* (Cement Mill Section), **20,** 63–73(1922).—A description of the raw materials, equipment, mfg. processes, and the cement produced at the 7 plants of the Asano Portland Cement Company. J. C. WITT (*C. A.*)

175. Possibilities of fusion process for cement production. S. L. MEYERS. *Concrete* (Cement Mill Section), **20,** 105–7(1922).—M. states that the fusion process has

certain advantages in fuel economy not possessed by the sintering method, and that it does not present insurmountable difficulties. J. C. W. (*C. A.*)

176. Some causes of cracking and disintegration of Portland cement concrete. R. E. STRADLING. *Concrete & Constr. Eng.*, **17**, 393–8, 475–80(1922).—S. states that the reasons for cracks and disintegration are very numerous, not well defined and in many cases not understood. In explaining the probable causes sometimes involved, he places them under 4 groups: (1) compn. and phys. state of the cement as received, (2) misuse of the cement, (3) compn. and phys. state of the aggregate employed, (4) conditions to which concrete is exposed. Under (1) he mentions the presence of "dead burnt" lime and magnesia and the possibility of this material slaking after the cement has been hydrated, sulfo-aluminates, and degree of grinding. Group 2 includes (*a*) setting time of cement and amt. of water used, (*b*) proportion of cement, (*c*) methods of molding; (3)—(*a*) water, (*b*) fine aggregate, (*c*) coarse aggregate, (*d*) artificial aggregates; (4)—(*a*) moisture, (*b*) electrolysis, (*c*) rusting of reinforcing steel. He concludes that by far the greater no. of failures are due to faulty workmanship or the condition to which the work is exposed. Only a few can be traced to bad materials.

J. C. WITT (*C. A.*)

177. Constitution and hydration of Portland cement. A. A. KLEIN. *Zement*, **10**, 636–8(1921); *Chimie et industrie*, **7**, 1150(1922).—A review of Richardson's theory of the constitution of cement and of Vicat's, LeChatelier's, Richardson's and the U. S. Bur. of Standards' theories of hydration. A. P.-C. (*C. A.*)

178. The use of slag cement in construction work. KROPF. *Zement*, **10**, 651–2 (1921); *Chimie et industrie*, **7**, 1150(1922).—Certain brands of slag cements are more sensitive to a strong premature desiccation than Portland cement; but in the presence of brine slag cement hardens more readily than many Portland cements. When properly sprinkled, it is suitable for elevated structures. Owing to the fineness of grinding, large quantities of sand can be added, and the resulting mortars are still relatively strong. Owing to its low CaO content, it is stronger than many Portlands. K. gives the compns. and methods of prepn. used in mining work, more particularly for filling up fissures in rock by injection. A. P.-C. (*C. A.*)

179. Lime-silica-iron oxide. H. KÜHL. *Zement*, **10**, 361–4, 274–6(1921).—Alumina is not an essential component of hydraulic cements. The production of cements rich in iron oxide requires the presence of silica in a highly reactive form. The sintering of such cements is similar to that of Port. cement. The hydraulic constituent is tricalcium silicate. The area occupied by cements rich in iron oxide in a triaxial diagram of the system: lime–silica–iron oxide is in nearly the same position as that of the Port. cements in the system: lime–silica–alumina. J. S. C. I. (*C. A.*)

180. Hydraulic setting properties of basic blast-furnace slags. W. KREBS. *Zement*, **11**, 1–3, 15–17, 40–4(1922).—A long series of expts. and a study of the work of previous investigators have shown that all basic blast-furnace slags in a glassy, granulated state can be converted into hydraulic cements by the addition of alkali minerals and gypsum. Such cements harden better than is required by the (German) standard specification, and they are unaffected by 3 months' storage. J. S. C. I. (*C. A.*)

181. Standard and tentative methods of sampling and testing highway materials. U. S. Dept. Agr., *Bull.* **949**, 98 pp.(1921); *Expt. Sta. Record*, **45**, 891.—Standard specifications, as recommended and adopted by the second conference of State highway testing engineers and chemists at Washington, D. C., Feb. 23–27, 1920, are given. These include tests for both bituminous and nonbituminous road materials and tentative tests, as well as forms for recording and reprinting results. H. G. (*C. A.*)

PATENTS

182. Plastic composition. EARLE E. SCHUMACHER. U. S. 1,422,483, July 11,

1922. A plastic composition of approximately the following composition: Glycerine 4 parts, plaster of Paris 10 parts, water 1½ parts. C. M. S., Jr.

183. Apparatus for forming concrete pipes. Daniel N. Trullinger and Leo A. Granger. U. S. 1,422,150, July 11, 1922. An apparatus for the purpose set forth comprising a shell, a core disposed longitudinally within the shell, a head supported upon the shell and adapted to travel longitudinally thereof and normally fitting around the front end of the core, and means whereby the shell, the head and the core may each be shifted longitudinally relative to the others. C. M. S., Jr.

184. Cement spreader. Charles J. Bellar. U. S. 1,419,537, June 13, 1922. A spreading machine comprising a receptacle having a distributing compartment at its bottom and wheels at its front within the compartment adapted to support the receptacle in a rolling movement over a floor. C. M. S., Jr.

185. Machine for mixing concrete ingredients or other substances. Frederick W. Kiddie. England. 1,419,737, June 13, 1922. For use in machines for mixing concrete ingredients or other substances, beaters mounted upon a shaft, each beater consisting of a single shank carrying a fork, and having chain form connecting means between the prongs of same, the shanks being inclined out of the radial lines, in order that the forks and chain form connecting means work the concrete endwise of the trough and more perfectly mix the concrete. C. M. S., Jr.

186. Insert for cement or similar floors. Charles H. Fay. U. S. 1,419,548, June 13, 1922. An insert for concrete or similar floors comprising a lower tubular member with an annular flange at the bottom, the flange having anchor elements on its top face, an upper tubular member with an annular flange, a metal sleeve between the flanges and enclosing the inner ends of the members, and means in one of the tubular members for supporting a pipe, the flange serving as a member for securing the support on entering so as to withstand the pouring of cement around the member. C. M. S., Jr.

187. Plastic composition. Kenneth L. Binkley. U. S. 1,418,905, June 6, 1922. A composition of matter comprising pitch and magnesium carbonate, the composition having a melting point of about 200°F. C. M. S., Jr.

188. Apparatus for making concrete bricks. Arthur G. Hatch. 1,425,590, Aug. 15, 1922. Apparatus for making concrete brick or the like, comprising a molding deck, spaced parallel septums of metal extending vertically from the deck, removable pallets fitted between the septums, the bodies of the pallets being formed of wood and being faced with metal having upwardly extending portions adapted to form the end faces of the brick, the pallets being provided with handling clips whereby they may be removed from the molding deck. C. M. S., Jr.

189. Cement tile-making machine. William Gillard. Canada. 1,424,469, Aug. 1, 1922. In a cement tile-making machine, the combination with a mold carrier and molds, means for guiding the mold carrier freely vertically, formers operating within the molds to force the carrier downward as the tile is built up, and counter weights opposing the downward pressure exerted on the mold frame, of normally vertical counterweighted lever bars mounted upon a swingable support, and means operated by the upward travel of the counter weights for drawing the counter weighted lever bars from the vertical to the horizontal position. C. M. S., Jr.

190. Plaster support for walls. Stephen J. Potter. U. S. 1,423,879, July 11, 1922. A paper wall board, comprising a strip of paper of laminated structure, having transverse strengthening ribs spaced apart thereon and attached thereto, each rib being formed transversely into an arch through the greater part of its length but flattened at the ends. C. M. S., Jr.

191. Appliance for throwing mortar for the plastering of walls. Theodor Moser.

Germany. 1,423,536, July 11, 1922. Mortar-throwing apparatus comprising a hopper, a casing into which the hopper discharges, a nozzle leading from the casing, a screw conveyor arranged for rotation in the casing and the flight of which decreases in pitch toward the discharge end of the conveyor, means to discharge compressed air through the conveyor and the nozzle, and driving means for the conveyor.

C. M. S., Jr.

BOOK REVIEW

The Potter's Craft. Chas. F. Binns. 2d. ed. D. Van Nostrand and Co., New York, 1922. The amateur student of ceramics will call blessings upon the head of Professor Binns for his enlarged second edition of "The Potter's Craft."

The Introduction and Chapter on Applied Art are an everlasting foreword for any craftsman or society of Handicraft, whatever the nature of the craft, and exemplifies their reason for existence.

The Chronological Review, of early Chinese to contemporary French and English, runs along racily. It touches upon various phases and outstanding ceramic figures with comment and salient distinctions so pointedly brought out that the lay reader acquires a comfortable sense of being conversant with the chief facts of Ceramic History.

Chapter four leads one to take his spade and discover local clays and gives practical directions for preparing, sieving, shaping and firing. Descriptions of specific clays and their characteristics are discussed and the uses for which they are suitable are defined. The subsequent painstaking details of mold-making, casting, throwing, etc. make one marvel that one who has the greatest scope as a technical educator should have the patience to work out, step by step, all the minutiae, so that the veriest amateur may know the joy of producing. What, but the greatest love for his craft and the greatest sympathy for the most feeble attempts in it, could animate such long suffering and patience!

Surely the amateur in no other craft is so shut out because of the wall of technical terms used by the trained ceramist. He has no language in which even to present his difficulties. In this work scientific expression is so qualified that the layman can, at least, follow the trend of professional method.

This is true especially of the chapters on glazes. The scientific compounding of a glaze batch is so explained that the serious student is inspired to embrace real knowledge in his efforts.

For school work, the book will prove a boon inestimable, as it gives the teacher of many crafts, a working idea of cause and effect, and furnishes formulae together with explanations of their type and application. So alluring is the chapter upon porcelain, that, having been led back to the source, the Chinese, you are keen to try for the impossible and to pursue "Liquid Dawn" or "The Red of the Bean-blossom."

Those who have sat at the feet of Prof. Binns and profited from his vivid presentations, will qualify his words "The personal note, tone and picture may be lost in reading from the printed page" with the reservation to the effect that we do regain an impression of his crisp recital and clean cut utterance which will keep his admonitions and appreciative encouragement always vivid in our minds. Mary Chase Stratton

AUTHOR INDEX TO ABSTRACTS

The references are to page numbers. The capital letters in parentheses have the following significance: (A) Abstract, (E) Editorial, (B) Book, (P) Patent.

A list of the abbreviations used in the Index is found on p. 381.

VOLUME 1

A. R. Method of chem. anal. of gypsum and plaster, A (5) 149.
Abrams, V. R. Kavanagh, J. T., and Osmond, C. H. Air bubble viscosimeter, A (10) 246.
Adams, F. W. Making white flint glass in tank fur., A (12) 330.
Adams, L. H. and Williamson, E. D. Annealing of glass, A (4) 115.
Adolf, M. and Pauli, W. Gen. colloid chemistry, A (4) 104; Gen. colloid chemistry. IV. Phys.-chem. anal. of aluminium oxy salts and aluminium oxide sols., A (6) 161.
Ager, J. W. Hollow bldg. tile, P (11) 286.
Agg, T. R. and Goldbeck, A. T. Standard and tentative methods of sampling and testing highway mats., A (4) 117.
Agthe, J. Some simplified formulas for excess air, A (10) 248.
Alexander, J. Colloid chemistry, A (12) 310.
Alleman, G. Manuf., properties and employment of ht.-intercepting structural glass, A (5) 145.
Allen, B. J. Drying stoves scientifically designed, A (1) 5.
Allen, W. H. Brick-hacking mach., P (11) 271; Weatherproofing clay, P (12) 305.
Alliott, E. A. Recessed plate and plate and frame filter presses; their construction and use, A (7) 178.
Amenomiya, Y., Kojima, K. and Ota, H., Atmospheric press. and refractive indices with corresponding table of indices of optical glass, A (11) 290.
Ames, A. Jr. Systems of color standards, A (4) 100.
Anderson, A. H. Abrasive and refrac. articles, P (11) 280.
Anderson, W. S. Calcium silicide, new deoxidizing agent, A (2) 36.
Andrews, W. S. Notes on prepn. of some fluorescent and phosphorescent compds., A (11) 276.
Andrieux, L. Zirconium and zirconium oxide, A (8) 209.
Anstett, F. Influence of drying on resist. of cement briquettes, A (5) 148.
Appleby, W. R. Practical interpretation of automatically recorded volumetric percentages of carbon dioxide in flue gases, A (10) 249; Practical economization of coal fuel and responsibility for it, A (12) 304.
Armitage, A. N. Pyrometer from standpoint of user, A (2) 33.
Armstrong, P. A. E. App. for molding hollow bodies, P (12) 327.
Arnemann, K. Gas manuf. and tar recovery with attention to carbonization of lignites, A (5) 130.
Arnold, H. Progress of colloidal chemistry in ceram. since end of World War, A (2) 36.
Arrhenius, O. Clay as ampholyte, A (8) 203.
Ascher, F. H. Cryst. magnesite at St. Martin, Salza, A (3) 65.
Ashenhurst, H. S. Ht.-insulating mat., P (6) 159.
Asselberghs, E. Kaolin in Belgium, A (1) 8.
Atkinson, J. S. Steel-works fur. and gas producers, A (5) 141; Powdered fuel, A (6) 156.
Audley, J. A. Condition and prospects of Brit. ceram. indus., A (4) 97.
Augen, A. C. Potash and white cement, P (6) 171.
Austin, M. M. and Parr, S. W. Potash shales of Ill., A (2) 53.
Avrutik, J. Continuous and automatic shifting process for sepg. liquids and solids, A (1) 4.
Azbe, V. J. Boiler plant efficiency, A (5) 129.
Backheuer, M. Prepn. of dolomite-tar mixt. in Thomas (basic converter) steel works, A (2) 39.
Badder, H. C. Water-proofing compn. for cement or similar materials, P (5) 150.
Baer, M. Building material from plaster of Paris, P (4) 122.
Bailey, A. See Taylor, W. C.
Baillie, W. L. Reln. between d. and compn. of glass, A (5) 145.
Baillie, W. L. and Wilson, F. E. Autoclave test for grading of chem. glassware, A (10) 260.
Bain, H. F. Bur. of Mines and private invest., A (5) 128.
Baker, F. P. Study of fundamental laws of filtration using plant-scale equipment, A (2) 33.
Balderman, C. Circ. flattening ovens and leers for plate glass, bottles, etc., A (4) 111.
Baldermann, J. New method for setting regenerator chambers, A (3) 74; Copper ruby glass for casing, A (4) 111.
Bales, C. R. Refrac. cements and protective coatings, A (11) 276.
Balz, G. A. Refrac. brick, P (8) 210.
Balz, O. See Wöhler, L.
Bangley, A. G. Gypsum in Brit. Columbia, A (9) 239.
Bansen, H. Calcn. of working temp. in met. fur., A (8) 209.
Baragwanath, J. G. Vanadiferous asphaltes of central Peru, A (9) 233.
Barba, W. P. and Howe, H. M. Acid open-hearth process for manuf. of gun steels and fine steels, A (8) 208.
Barbeau, H. M. Glass-cutting table, P (7) 188.
Bardrof, F. E. See Gray, D. E.
Barkby, H. Description of tunnel kiln in Czecho-Slovakia, A (12) 302.
Barlot, J. and Martinet, Jh. Note on formation of blow-holes in earthenware glazes, A (1) 12.
Bartel, P. Latest lit. on "lead question," A (11) 281.
Barton, L. J. Elec. steel plant at So. Pacific shops, A (11) 278.
Bary, P. Les Colloides: Leurs gelées et leurs solns., B (2) 32; Electroösmosis, A (10) 245.
Bassett, H. See Hudleston, L. J.
Bassett, H. P. Alumina and potassium compds. from feldspar or similar mat., P (6) 162; Basic refrac. compn., P (4) 108; Basic refrac. mat., P (1) 11; Acid-proof refrac. compn., P (1) 11.
Bates, P. H. Cementing qualities of calcium aluminates, A (2) 53.
Battegay, M., Hugel, G. and Voltz, Th. Decompn. of glass of ancient windows in church of Thann, A (12) 332.
Bawtree, A. E. Theory and practice in color meas. and recording, A (10) 256.
Baxter, G. P. Twenty-eighth Ann. Rept. of Comm. on Atomic Weights. Detns. pub. during 1921, A (7) 177.
Bayer, F. M. Improvements in meas. app. for gases, vapors, liquids and granular subs., A (9) 225.
Bayley, W. S. Kaolin in N. Car. with brief note on hydromica, A (4) 102.
Baylor, H. D. Cement, P (3) 92.
Beach, L. M. Feldspar in 1920, A (4) 103; Silica in 1920, A (3) 65.
Beach, L. M. and Coons, A. T. Abrasive materials in 1920, A (4) 109.
Bean, G. M. Interlocking brick, P (12) 326.
Beckenkamp, J. Atomic grouping and optical rotation of quartz and sodium chlorate, A (4) 100.

Becker, I. H. See Weiss, J.
Beckman, J. W. Ceram. as by-product of coal mining in Sweden, A (3) 58.
Beecher, M. F. Translucent anti-slipping tile, P (3) 82.
Beecher, M. F. See Purdy, R. C.
Behre, C. H., Jr. Native antimony from Kern Co., Calif., A (5) 137.
Bell, J. E. Cement-kiln plant and method of operg. same, P (5) 150.
Bellamy, H. T. and Sweely, B. T. Glass, P (10) 260; Glass compn., P (11) 292.
Bellar, C. J. Cement spreader, P (12) 339.
Bencke, A. Colloidal character of clay from practical point of view, A (5) 138.
Benham, Charles E. Liquid inclusions in glass, A (7) 186.
Benischke, G. Die Porzellan-Isolatoren, B (7) 184.
Bensa, F. Paints; cements, P (4) 121.
Benson, E. J. Plastic-block mold, P (7) 177.
Benson, H. K. Auxiliary electrochem. developments for hydroelec. plants, A (7) 177.
Berline, R. Centrifugal decantation, A (7) 176.
Bernaola, V. J. Formation and constitution of kaolin, A (5) 138.
Berry, H. C. and Hart, L. C. Rept. of Comm. C-7 on lime, A (3) 89.
Berthelot, C. Methods for measg. large vols. of gas, applicable to gas plants or coke ovens, A (2) 34; Exposition of app. for control of combustion organized by Office Central de Chauffe Rationelle (March 12–25, 1921), A (4) 98.
Bertin, C. Anal. of gypsum in cements, A (10) 260.
Bertrand, L. Compn. and micro-structure of clays and their fusibility at high temps., A (9) 232.
Bertrand, L. and Lanquine, A. Siliceous rocks considered from viewpoint of manuf. of silica bricks, A (2) 40.
Best, W. N. Burning liquid fuel in jets, P (5) 131.
Beutel, E. Etching of flashed glasses, A (3) 81.
Bichowsky, F. R. Expts. with ht.-interchangers, A (7) 174.
Bichowsky, F. R. and Merwin, H. E. Silica-glass for refractometry of liquids at elevated temps., A (4) 116.
Bied, J. Refrac. products indus., A (4) 107.
Bied, J. and Garnier, E. Law governing hardening of cement, A (1) 26.
Bigot, F. Manuf. of culinary ware, A (9) 235.
Binder, F. O. H. Flue gas testers, A (8) 200; Constitution and ht. of combustion, A (8) 197.
Bingham, E. C. Fluidity and plasticity, B (6) 172; Progress in metric standardization, A (8) 198.
Binkley, K. L. Plastic compn., P (12) 339.
Binns, C. F. The potter's craft, B (12) 340.
Birdsey, C. R. Method of calcining gypsum rock, P (11) 297.
Bishop, E. See Burton, E. F.
Bishop, J. A. Condenser for shale-oil, etc., P (7) 177.
Bitting, A. W. Comparative strength of prescription bottles, A (3) 75; Causes of loss in bottles during pasteurization and sterilization, A (3) 73; Free alkalinity in glass containers, A (7) 187.
Blackmore, H. S. Sol. compds. from feldspar, P (4) 104.
Blanc, E. C. Modern installation for crushing and screening basalt, A (8) 196.
Blass, F. M. E. Gas producer, P (10) 246.
Blaszkowskie, H. and Z. See Swientoslawski, W.
Bleininger, A. V. III. Prepn. and compn. of ceram. bodies for spark plug insulators, A (1) 9; Kaolins and pottery clays in U. S., A (4) 109.
Bleriot, Ltd. Elec. insulating compns., P (4) 108.
Blizard, J. Prepn., transportation and combustion of powdered coal, A (5) 129.
Blizard, J. and Malloch, E. S. Lean coals tested in gas producer, A (6) 157.
Block, M. Reln. of employer and employee as regards ownership of patents, A (10) 246.
Blücher, H. From lab. expt. to factory app., A (8) 197.
Blum, A. Milk or alabaster glass, A (3) 77.
Blyth, H. Importance of low handling costs, A (8) 198.
Boddie, C. A. Elec. furnace regulator system, P (11) 279.
Bodin, V. Resist. tests on refrac. products under load at diff. temps., A (11) 277.
Bogitch, B. Expansion of refrac. mats. at high temp., A (6) 163.
Bogue, R. H. Swelling and gelation of gelatins, A (3) 60.
Boisselet, L. See Gault, H.
Booth, G. W. Tunnel-kiln, P (7) 183.
Bordas, F. and Touplain, F. Detn. of d. and methods of expressing it, A (6) 161.
Borgström, L. H. Melting and b. p. of minerals, A (2) 37.
Born, M. and Brody, E. Sp. ht. of solids at high temps., A (9) 230.
Bostock, F. J. Gaseous firing for indus. purposes, A (6) 156.
Boudouard, O. Phys. and mech. testing of porcelain insulators, A (2) 43; Porcelain for elec. insulators, A (6) 164.
Bowen, N. L. Diffusion in silicate melts, A (1) 8.
Boydell, H. C. Euboean magnesite field, A (5) 133.
Boyer, J. Brick fur. or kilns, P (6) 164.
Boys, C. V. See Donkin, S.
Bradfield, R. Centrifugal method for prepg. colloidal ferric hydroxide, aluminium hydroxide, and silicic acid, A (10) 251.
Bradley, L. App. for elec. pptn. of suspended particles from gases, P (6) 159.
Bradley, W. E. F. and A. B. Tilting elec. fur., P (9) 234.
Bradshaw, L. and Emery, W. Rept. of refrac. Mats. Research Comm. to Inst. of Gas Engineers, A (2) 38; Behavior of clay pyroscopes and fire-clay bricks in coal gas, A (1) 9; Influence of oxidizing and reducing atmospheres on refrac. mats., A (12) 315; Notes on jointing mat. for refrac., A (12) 315.
Braillion, Ch. Making clay brick, A (9) 236.
Braley, S. A. and Hobart, F. B New method for detection and estn. of cobalt, A (7) 175; Braly, A. Rapid tests for copper in pyrite and iron minerals, A (11) 275.
Bräuer, Adolph. Titration app. with automatically fixed zero point, A (8) 200.
Bray, C. T. Slag-brick mach., P (12) 326.
Breerwood, C. H. Dolomite brick, P (3) 67; Fur. lining, P (3) 68.
Brémond, P. See Granger, A.
Brettschneider, F. Manuf. of brick, P (5) 147.
Briggs, C. A. and Gordon, E. D. Weighing by substitution, A (9) 230.
Briggs, H. Adsorption of gas by charcoal, silica and other subs., A (4) 102.
Briggs, W. A. Enamel, P (11) 295.
Broadberry, A. E. Rept. of Refrac. Materials Research Comm., A (11) 278.
Brockbank, C. J. Abrasive, P (6) 164.
Brody, E. See Born, M.
Broeksmit, T. C. N. Zinc borate, A (8) 202.
Brookby, H. E. Parallel current calcining-kiln, P (1) 12.
Brophy, G. R. Calcite—New ht.-resisting alloy, A (8) 198.
Brown, A. L. Manuf. of glass milk bottles, A (7) 187.
Brown, R. P. Sand-lime brick and sand-lime mortar, A (9) 242.
Brown, W. F. Occurrence of crust or scum on continuous bottle tank fur., A (3) 79; Stirring molten glass in continuous tank fur., P (11) 291.
Bruce, A. Action of sulphur on cement in tropics, A (4) 119.
Buch, A. E. Manuf. of ceramite, A (8) 215; Modern tunnel-kiln, A (9) 225.

Buckingham, E. On plastic flow through capillary tubes, A (3) 64.
Buckley, H. See Masson, I.
Buckman, H. H. and Pritchard, G. A. Refrac. compn., P (3) 68; P (10) 255.
Bührer, A. Improved methods of brick manuf., A (4) 117.
Bujor, D. I. Chem. compn. of cement, A (6) 170.
Burchard, E. F. Cement in 1919, A (3) 91.
Burchartz, H. Expts. with blast-fur. slag, A (2) 50; Researches with blast-fur. slags, A (6) 170; Blast-fur. cement, A (7) 192.
Burgess, W. Tariff revision and regulation, A (12) 302.
Burgoon, C. E. See Whitlock, E. H.
Burrie, H. Proper lubrication of ball bearings A (2) 31.
Burton, E. F. and Bishop, E. Law of distribution of particles in colloid soln., A (8) 204.
Busby, H. S. Use of secondary ref. standards in process probs. of color meas., A (8) 212, A (9) 235.
Bush, H. J. Elec. pptn., A (9) 225.
Bush, V. and Connell, L. H. Effect of absorbed gas on condy. of glass, A (12) 330.
Byelvankin, D. Sp. gr. and refraction of potash-soda-feldspars, A (12) 309.
Byrnes, C. P. Method of and app. for drawing glass, P (12) 333.

Cahill, W. E. Elec. furnace iron and steel, A (10) 251.
Callard, R. P. Sheet-glass drawing mech., P (7) 190.
Callard, R. P. and Rhonemus, C. E. Sheet-glass drawing mach., P (5) 145.
Candolt, E. Tests on mortars and concrete immersed in sea water for 15 years, A (10) 261.
Carlsson, F. See Sieurin, E.
Carpenter, C. H. Elec. crucible fur., P (9) 234.
Carpmael, W. Silicate cements, P (4) 121.
Carstens, A. B. Rotary kiln, P (11) 279.
Carter, Wm. O. See Marconet, P.
Cartner, A. T., Clewer, R., and Mather and Platt, Ltd. Vacuum filtration app., P (6) 160.
Carus, M. Improved iron-manganese sepn., A (5) 136.
Caruthers, M. W. Opern. of basic elec. fur., A (5) 140.
Catlett, C. Recovering potassium compds. in cement manuf., P (4) 122; Segregation as it applies to tanks as segregating or mixing devices, A (12) 337.
Cawood, R. L. Potter's clay, P (10) 256.
Ceriat, E. Tile construction, P (12) 326.
Chand-ratreya, V. L. See Winch, H. J.
Chapman, L. W. Electrified cement indus., A (1) 26.
Chapman, W. B. Fuel saving in modern gas producers and indus. fur., A (5) 129; Gas producer, P (10) 246.
Chappell, H. F. Calcining alunite, P (6) 163.
Charles, H. L. Fur. roofs, P (7) 183.
Charlton, H. W. Hydrating lime, P (3) 93.
Charriou. Sepn. of ferric iron and aluminium from calcium by nitrate method, A (9) 230.
Chase, E. G. Glass-handling app., P (11) 292.
Chatley, H. Mol. force and plasticity of clays, A (1) 7; Cohesion, A (4) 101.
Chaudet, A. Ultramarine pigments, A (2) 37.
Chauvisé, J. Htg. of porcelain oven by means of fuel oil, A (12) 318.
Chevenard, P. Thermal expansion of chromium and nickel-chromium alloys over extended range of temps., A (8) 197.
Clapp, A. L. Glass-treating fabric and emulsion, P (8) 217.
Clare, R. L. Oil burning in ceram. plant, A (12) 302.
Clark, H. F. Carrier for glass articles, P (7) 190; Manuf. of sheet glass, P (12) 334.
Clark, W. G. Glass fur., P (2) 49; Automatic elec. ht. device for glass fur., P (12) 333.
Clarke, J. R. Elec. properties of glass, A (2) 48; A (7) 187; Effect of rays from radium, X-rays, and ultra-violet rays on glass, A (10) 259; A (12) 328.
Clarke, J. R. and Turner, W. E. S. Some optical properties of sodium-aluminum trisilicate glasses, A (1) 21.
Claus, R. Engineers for firing technique in ceram. indus., A (4) 97; Thermal "balance-sheet" of annular kiln, A (4) 105.
Clawson, M. S. Refrac. cover for elec. furs., P (8) 201, P (9) 234.
Clewell, R. F. Producer gas plant design, A (9) 224.
Clewer, R. See Cartner, A. T.
Close, J. V. Hollow tile, P (5) 143.
Clouser, H. E. and Thornton, E. R. Means for making bldg. blocks, P (8) 215.
Clymer, A. A. Tool for handling tiles, P (7) 185.
Cobb, J. W. See Houldsworth, H. S.
Cobb, J. W. and Wood, J. W. Recording calorimeters, A (5) 132.
Cobb, R. See Flinn, A. D.
Coblentz, W. W. Progress in mfg. radio-protective glasses, A (1) 19.
Colburn, I. W. Process and app. for drawing sheet-glass, P (5) 146.
Colby, O. A. Elec. glass-annealing fur., P (6) 167.
Cole, C. A. Use of light soda ash in production of flint bottle glass, A (3) 79.
Collins, D. E. Refrac. compn., P (8) 210.
Collins, E. F. Temp.-control devices for elec. fur., P (4) 109; Elec. ht. for thermal proc., A (7) 178.
Colony, R. J. Judging quality of Port. cement, A (2) 51, A (7) 193.
Comber, N. M. Flocculation of soils. II, A (6) 171; Characterization of clay, A (8) 198.
Comstock, G. F. Fusibility of open-hearth slag contg. titanium dioxide, A (7) 182.
Connell, L. H., Jr. See Bush, V.
Connick, C. J. Stained and painted glass, A (3) 71.
Coons, A. T. See Loughlin, G. F.
Cornelius, C. E. Elec. rotating fur., P (5) 133.
Cornille, A. Making of stanniferous faience, A (8) 210.
Couch, J. F. Evolution of chem. terminology. I. Coagulation, A (8) 196.
Cowell, R. E. and Wilkinson, A. App. for drying bricks, stones and ores, A (11) 285.
Cowperthwaite, W. T. Means for use in manuf. of concrete roofing tile, P (7) 194.
Cox, C. F. Mach. for making glass bottles, P (1) 23.
Cox, J. Compd. glass sheets, P (10) 260.
Cox, O. M. and Rose, C. C. Sheet glass drawing mach., P (12) 334.
Craven, M. B. See F. S. Sinnatt.
Craver, H. W. Devitrification of glass, A (3) 79.
Crawford, W. W. Manuf. of brick, P (5) 143.
Creighton, E. E. Soln. of porcelain insulator prob., A (2) 44.
Crockatt, C. C. See Hull, W. A.
Cross, A. K. Drawing and painting glass, P (1) 21.
Crossley, P. B. Process of manuf. of glass using natural silicates, such as micaceous minerals, asbestos, etc., P (5) 146; Glass contg. mica or asbestos, P (7) 188.
Crow, W. and Schaffer, J. C. Burning lime, P (3) 92.
Crowley, J. E. Method and app. for drawing sheet-glass, P (5) 146.
Crowley, J. E. and Rowley, C. A. Method and app. for producing sheet-glass, P (12) 332.
Cruikshank, J. W. Carrying large plate glass sheets, A (2) 48.
Culbertson, A. L. Comparison between stationary and mech. producers, A (10) 245.
Culbertson, W. R. New recuperative pot fur., A (10) 259.
Curtis, E. H., Jr. Glassware-mach., P (1) 24.
Curtiss, W. H. Pyrex; a triumph for chem. research in indus., A (9) 236.
Cutler, F. G. Reduction of fuel wastes in steel indus., A (8) 209.

D'Adrian, A. L. D. Opal glass, P (11) 293.

Daeves, K. Use of optical pyrometer in practice, A (8) 200.
Dahle, A. Dry purification of kaolins, A (8) 196.
Dahse, W. Increasing adhesive properties of alkali silicate solns., P (4) 105.
Dalladay, A. J. and Twyman, F. Meas. of small variations of refractive index throughout meltings of optical glass, A (12) 328.
Danielson, A. Union gas calorimeter, A (11) 271.
Darling, C. R. Pyrometry: Prac. treatise on meas. of high temps., B (1) 6.
Darling, C. R. See Wainford, R. H.
Dautrebande, J. Homogeneity and raw materials of cements, A (8) 217.
Davey, Wheeler P. New X-ray diffraction app., A (8) 200.
Davis, E. F. Function of insulation and application to ht.-treating fur., A (1) 8.
Davis, H. W. Fluorspar and cryolite in 1920, A (2) 38.
Davis, J. D. See Ratliff, W. C.
Davis, N. B. Feldspar deposits of Ottawa Dist., A (11) 273.
Davison, W. B. Gas calorimeters, P (6) 159.
De Fernelmont, L. H. Bldg. tile and wall made therefrom, P (7) 184.
Degelow, C. Firing with coal dust, soln. of fuel prob., A (4) 108.
Delany, E. H. and Payne, S. H. Gas-analysis app., P (7) 179.
Delaunay, J. E. See Dimitri, G. L.
Delcourt, E. Scien. method of quarrying slate, A (10) 244.
Demuth, W. Mech. tests for raw mats. used in manuf. of porcelain, A (11) 283.
Denk, F. J. Use of medium grade gases in steel indus., A (6) 155; Importance of clean gas for producer plant, A (9) 224.
De Nolly, H. Elec. fur. adapted for refining mats., P (11) 279.
Deputy, H. S. Glass-cutting mech., P (7) 188.
De Steigner, W. G. Continuous kiln, P (7) 183.
Desvigness, E. See Rengade, E.
Deulin, F. E. Method and app. for drawing sheet glass, P (7) 188.
Deussing, P. Artificial meerschaum, P (3) 59; P (6) 158.
Devereux, P. S. See Mellor, J. W.
Dibble, S. E. Clay pipe pronounced equal to cast iron pipe, A (10) 258.
Dickinson, W. W., Jr. App. for burning brick, P (7) 182; P (7) 183.
Didier, C. Burning cement in two stages, A (12) 335; Artificial cement by "two fire" practice, A (3) 88.
Dietrich & Co. Enameling, P (4) 118.
Diller, H. E. Melts aluminium in elec. fur., A (10) 253.
Dimbleby, V., Hodkin, F. W. and Turner, W. E. S. Influence of aluminum on working properties of glass, A (1) 20; Some properties of lime-magnesia glasses and their commercial application, A (12) 328.
Dimitri, G. L. and Delaunay, J. E. Manuf. of refrac. and insulating products, P (9) 234.
Disch, J. H. Thermal expansion of some subs., A (2) 36.
Doane, S. E. Suggestions concerning college ed. of an engineer, A (12) 305.
Dobbins, J. C. Plastic coating material contg. cement, P (4) 122.
Dobbs, C. and Painter, A. E. App. for drying and medicating air, P (9) 226.
Dochnal, F. Interlocking tile, P (12) 327.
Dochnal, M. Open-end hollow tile for wall structures, P (7) 184.
Dodge, H. K. Anti-slipping tile, P (3) 82.
Doenges, W. Meissner Porzellan, B (10) 256.
Doerr, C. F. Rotary glass cutter, P (12) 333.
Donath, E. Burning lime with coal with high sulphur content, A (4) 118.
Donauer, M. Uses for indus. enameled equipment, A (5) 148.
Donkin, S. Rept. of lubricants and lubrication inquiry comm., B (2) 32.
Dowson, P. E. See Ferguson, A.
Drakebusch, W. Increase in strength of sand-lime brick, A (2) 45; Slaking of lime when mixed with sand, A (4) 118.
Dressler, P. d'H. Tunnel kiln with sectional combustion chambers, P (1) 11.
Drury, C. W. Cobalt oxide in Can., A (9) 229.
Dufva, K. O. Cementing or luting compn., P (8) 220.
Duguid, S. N. Fuel economy, excess air as cause of waste, A (6) 155.
Dunn, F. B. Paving brick, P (5) 144.
Dunnachie, J. See Smith, E. W.
Dupraz, A. Egyptian lime-silica brick, A (5) 149.
Duschak, L. H. Extraction of calcium oxide from calcined magnesite, A (3) 66.
Dwyer, J. R. Reln. between tensile and compressive strengths of cement mortars, A (2) 51.
Dwyer, P. Apply powdered coal to air fur., A (6) 154.
Dyrssen, W. Tilting elec. fur., P (11) 280; Electrode fur., P (11) 279.

E. S. Copper ruby glass for casing, A (4) 111.
Eardley-Wilmot, V. L. Graphite—recent developments in Buckingham dist., A (5) 134; Graphite in Can., A (12) 314.
Earle, R. W. Insulating and ht.-conducting mat. for elec. heaters, P (4) 109.
Eckel, E. C. Quick-hardening cement developed by French, A (4) 119.
Edgen, E. M. and C. G. Two machs. for rapidly weighing loads of few mgs., A (11) 270.
Ellery, E. Can college do anything for indus.? A (11) 268.
Elliott, G. L. Cast iron as produced in elec. fur. and some of its probs., A (10) 254.
Elsenbast, A. S. and Jordan, W. J. Insulating cement or mortar, P (12) 316.
Emery, W. Increasing plasticity of calcined gypsum, P (7) 193. See Bradshaw, L.
Emley, W. E. and Marani, V. G. Rept. of Comm. C-11 on gypsum, A (3) 90.
Emley, W. E. See Shelley, H. T.
Emslander, R. See Gutbier, A.
Endell, K. Behavior of refrac. brick under load at high temps., A (2) 39; A (8) 208; Special high resist. Port. cements, A (2) 49; New htg. microscope for high temps. with synchronous revolving nicols, A (2) 35; New elec. muffle fur. for temps. up to 1700°, A (8) 209; Magnesite plant of Austro-Amer. Mag. Co., Radentein (Kärnten), A (4) 105.
Enequist, E. W. Glass, P (6) 167.
Englehardt, W. Coal saving, A (4) 108.
English, S., Hodkin, F. W., Muirhead, C. M. M. and Turner, W. E. S. Influence of silica on annealing temp. of glass, A (3) 76.
English, S. and Turner, W. E. S. Density of glasses contg. aluminum, A (6) 166; Some properties of lime-magnesia glass and their commercial application, A (12) 327; Effect of aluminum on annealing temp. of glass, A (1) 20; Effect of sodium oxide on thermal expansion of sodium silicate glasses, A (1) 21; Thermal expansion of glasses contg. aluminium, A (12) 328.
Erdenbrecher, A. Notes on sodium silicate, A (6) 160.
Erwin, R. G. Plastic compn. and process for making same, P (7) 177.
Eschbaum, F. New stalagmometer or guttameter, A (10) 248.
Etchells, H. Present status of elec. fur. in steel making, A (8) 209.
Eucken, A. Theory of adsorption process, A (8) 205.
Evans, J. E. Brick, P (12) 327.
Everhart, E. Purifying bauxite, P (5) 139.
Evers, G. V. Note on compn. of glasshouse pots made in last 50 yrs., A (12) 330.
Eyoub, D. Converting dolomite into magnesite, A (5) 134.
Ezoe, M. Baking porcelain insulators, P (2) 45.

Fahrig, E. Artificial slate, P (4) 98.
Fairchild, C. O. Disappearing filament optical

pyrometer free from diffraction effects at filament, A (12) 305.
Farrant, J. C. Closed circuit grinding, A (12) 320.
Fasting, J. Rotary kiln, P (7) 183.
Faust, O. Viscosity meas., A (4) 99.
Faust, O. See Donkin, S.
Fay, C. H. Insert for cement or similar floors, P (12) 339.
Felcher, F. R. Dental cream.: a treatise on tech. of porcelain manipulation, A (2) 31.
Feldenheimer, W. and Plowman, W. W. Treating clay, P (10) 251.
Fels, W. T. Plaster mixt., P (11) 297.
Fereday, J. T. Glass decoration, A (7) 186.
Feret. Particle-size anal. of granular and powdered mats., A (7) 180.
Feret, R. One choice of mats. for use as sand in hydraulic mortars, A (9) 240.
Ferguson, A. Capillarity. I. General considerations and discussions of methods for meas. of interfacial tension, A (11) 274.
Ferguson, A. and Dowson, P. E. II. Modification of capillary-tube method for meas. of surface tension, A (11) 274.
Ferguson, L. A. Suggestions concerning college ed. of an engineer, A (12) 305.
Fermor, L. L. Clay in India, A (38) 308; Bauxite in India, A (12) 317.
Ferngren, E. T. Method of treating and working glass, P (11) 292; App. for feeding glass to molds, P (11) 293.
Ferrari, F. Special ferriferous agglomerate and its applications in presence of pozzuolanous subs., A (1) 25.
Fick, C. W. Elec. load condition in glass indus., A (1) 19.
Firth, E. M. and Turner, W. E. S. Effect of added feldspar on shrinkage and porosity of aluminous fire clays after being fired at high temps., A (3) 59; Shrink, porosity and other properties of Brit. fire clay after being fired at high temp., A (6) 166.
Fischer. Air cracks in grog products, A (4) 97.
Fischler, M. Draft device for labs., A (8) 200.
Fiser, J. See Kallauner, O.
Fisher, E. E. Glass compn. and method of making same, P (5) 146; Glass compn., P (7) 188.
Flagg, S. W. Low ash coal not always desirable, A (12) 304.
Fletcher, J. D. See Sullivan, C. L.
Flight, W. S. Dielec. strength of solid insulating mats., A (12) 321.
Flinn, A. D. and Cobb, R. Research lab. in indus. establishments of U. S., including consulting research labs., A (7) 175.
Flusin, G. The indus. of silica glass, A (3) 80.
Fonseca, E. L. See Honaman, R. K.
Formby, G. M. Oxychloride cement, P (3) 92; Plastic compn. and process of making same, (8) 220.
Forsyth, G. M. Art in pottery indus. (symposium on art), A (1) 15.
Forsythe, W. E. Current-temp. reln. for diff. pyrometer filaments, A (4) 98; 1920 Rept. of Comm. on Pyrometry, A (8) 200.
Forsythe, W. E. See Hyde, E. P.
Foshag, W. F. See Larsen, E. S.
Fourcault, E. Effect of sulphate and carbonate of sodium on hts. of fusion of soda-lime glass batches, A (5) 144.
France, W. A. Refrac. mat., P (11) 279.
François, M. and Lormand, C. Microscopic arrangement for examn. of opaque crys., A (10) 247.
Frazier, C. E. Simplex muffle leer, A (3) 75; Muffle oven for decorating glass or enamel ware, P (7) 188.
Fredl, G. Trass and Port. cement, A (4) 118.
French, C. A. Refrac. compn., P (11) 280.
Freymuth. Standardization of chem. app., A (2) 49.
Friedmann, J. Review of important Ger. patents on flotation with ref. to pat. of Mineral Sepn., Ltd., A (5) 129.
Friedrich, K. Cold glaze for cement, P (6) 172; Method of producing cold glaze for bldg. mats., in particular cement, P (7) 194.
Frink, R. L. Viscosimeters, P (6) 159.
Frion, P. Use of pulverized coal, A (4) 97.
Fritz, E. H. and Gilchrist, G. I. Modern production of (porcelain) suspension insulators, A (2) 45.
Frost, T. H. See McAdams, W. H.
Frydlender, J. H. International chem. index and reproduction of documents, A (8) 197.
Fuha, K. Color of glass imparted by iron, A (11) 289.
Fuha, K. and Yoshioka, Y. Opal and alabaster glass and their applications, A (11) 288; Action of ht. on refrac. clays and their rational analyses, A (11) 272.
Fukudo, T. Marine blue pigment for enameling, A (11) 294.
Fulton, C. E. Clay mixt. for earthenware manuf., P (5) 131; Manuf. of earthenware P (6) 172.
Fulweiler, W. H. Rept. of refrac. mats., A (5) 140.
Fulweiler, W. H. See Purdy, R. C.
Funk, H. See Manchot, W.
Funk, P. Method of draining tile, P (11) 286
Funk, S. M. Brick cleaning mach., P (12) 327.
Funk, W. Moissen porcelain for pottery and chem. ware, A (3) 71; Testing porcelain, kaolin and clay for whiteness, A (8) 210; Chromatics and its application to painting porcelain, A (11) 280; Modern developments in German fine ceram. products particularly in manuf. of porcelain and faience, A (12) 321.
Fuwa, K. Milky semi-transparent glass, P (11) 293.

Gage, H. P. Optical problems of glass making, A (12) 331.
Gage, H. P. See Taylor, W. C.
Gale, H. S. Callville, Wash., colemanite deposit, A (5) 134.
Gard, J. S. F. Estn. of small quantities of lime in presence of large quantities of magnesia, A (4) 103.
Gardner, H. A. and Holdt, P. C. Meas. of consistency of varnish, A (1) 6.
Garnier, E. See Bied, J.
Garstenauer, R. See Selch, E.
Gary, M. See Rieke, R.
Gaskill, J. See Pilkington, A. C.
Gat, J. D. Aluminum, tungsten and other oxides, alkali aluminates, tungstates, etc., P (7) 189.
Gates, A. W. Die for making articles of plastic material, P (5) 133.
Gault, H. and Boisselet, L. Use of commercial viscosimeters, A (12) 306.
Gelpke, V. Kiln with htg. chambers and cooling chambers, P (12) 305.
Gerbel, E. Mach. for working up ceram. masses into tiles, disks and similar bodies, P (12) 322.
Gibson, K. S., Tyndall, E. P. T. and McNicholas, H. J. Ultra-violet and visible transmission of various colored glasses, A (3) 77.
Gifford, J. W. Atmospheric press. and refractive indices, with corresponding table of indices of optical glass, A (11) 290.
Gignoux, M. Organism producing magnesia, A (1) 9.
Gilbert, L. F. See Masson, I.
Gilchrist, G. I. See Fritz, E. H.
Gill, G. M. Engineers and chemists, Coöp. of engineer and chemist in control of plants and process, A (5) 130.
Gillard, W. Cement tile-making mach., P (12) 339.
Gillot, M. See Guillerman, V.
Glasstone, S. Phys. chemistry of oxides of lead. I. Soly. of lead monoxide, A (4) 104; III. Hydrated lead monoxide, A (8) 202.
Gleckler, F. Arch-protector for clamp-kilns, P (5) 143.
Glekler, J. T. Ht.-resisting iron-chromium-nickel alloy, P (7) 188.
Goddard, W. T. Cement, P (7) 193.

Goldbeck, A. T. See Agg, T. R.
Goldbeck, A. T. See Thompson, S. E.
Goldschmidt, H. J. Aluminium oxide, P (4) 105.
Goldschmidt, V. M. and Ravner, O. Alumina from clay, P (4) 117; Metasomatism in siliceous rocks, A (6) 160.
Goldstine, S. Metallic carbides, P (10) 255.
Good, R. Method and app. for manuf. of glass, P (12) 332.
Gordon, E. D. See Briggs, C. A.
Goy, W. See Gross, W.
Graf, O. Resist. on vol. alteration of cement and cement mortars on setting, etc., A (2) 52.
Granger, A. Employment of alumino-thermic corundum as a refrac. product, A (2) 40; Glasses colored with copper-oxide, A (10) 258; Burning ceram. products in elec. heated fur., A (11) 276.
Granger, A. and Brémond, P. Chem. compn. of rock known as kaolin from Djebel Debar (Algeria), A (11) 272.
Granger, A. A. On nature of coloring props. of selenium red, A (11) 286.
Granger, L. A. See Trullinger, D. N.
Graulich, W. Ht. utilization and economy in steam power plants, A (6) 154.
Gray, D. E. App. for annealing glass or similar ht. treatments, P (3) 82.
Gray, D. E. and Bardrof, F. E. Method and app. for marvering glass, P (7) 188; Method of and app. for finishing blown-glass articles, P (7) 189.
Greaves-Walker, A. F. Development of new refrac., A (8) 208.
Green, A. T. Thermal condy. of refrac. mats. at high temps., A (11) 278.
Green, R. G. App. for rapid meas. of surface tension, A (10) 248.
Green, W. J. and S. S. Elec. tool steel melting practice, A (10) 252.
Greenleaf, L. S. Manuf. and use of coated abrasives, A (3) 68.
Greineder, F. Manuf. of gas-clinker brick at Wurzburg gas plant, A (2) 46.
Greisen, E. C. Prepg. and distributing powdered coal, A (8) 198.
Griepe, A. W. H. Continuous water-gas producer, A (6) 157.
Griffiths, E. Lab. type of elec. fur., A (2) 41; A (2) 42.
Grimm, F. V. See Patrick, W. A.
Grimwade, C. D. Recovery of gold residues, A (1) 12.
Gross, W. Flotation of sulfide ores in the lab., A (5) 138.
Gross, W. and Goy, W. Critical invest. on jig sieves (Schubert and Schuchard), A (5) 131.
Grossheim. Light plaster bricks, A (4) 118.
Grün, R. Iron blast fur. slags and their use as bldg. mat., A (8) 219.
Grunwald. B. B. Magnesium carbonate, P (4) 105; App. for producing magnesium carbonate from calcined magnesite, P (4) 105.
Grurnberg, W. A. Clayworking mach., P (5) 131.
Guédras, V. M. Construction of elec. steel fur., A (10) 246.
Guillerman, V. and Gillot, M. Elec. htg. fur. in steel works, A (2) 41.
Guillery. Compression test mach. for cements, A (7) 191.
Gundlach, K. Manuf. of reflecting surfaces, A (10) 259.
Gunnel. California silica sand operations, A (9) 234.
Gunther. Econ. use of fuel in manuf. of brick, A (12) 324.
Gutbier, A. and Emslander, R. Note on colloidal selenium, A (5) 134.
Gwosdz, J. Critical observations on generation of producer gas, A (6) 157.
György, P. See Rona, P.

Haacke, A. See Schwarz, R.
Hadaway, W. S., Jr. Elec. crucible fur., P (9) 234.
Haddon, C. L. Effect of some phys. conditions on calcium sulphate cements, A (3) 90.
Hagen, T. v. Weldability of solid powders by press., A (4) 99.
Hagermann, G. See Lorenz, R.
Hague, A. G. Off-bearing mechanism for tile cutters, P (11) 286.
Hahn, F.-V. v. Kinetic and static coagulation meas. with suspensions, A (6) 155.
Haigh. Burning with oil in Haigh kiln, A (8) 213.
Haigh, T. Durability of optical glasses. Rept. on an invest. on detn. of durability of optical glasses, A (12) 329.
Halen, S. Insulating mats., A (5) 129.
Hall, A. L. Corundum, A (3) 62; Corundum indus. in N. Transvaal, A (9) 234; Corundum in N. and E. Transvaal, A (12) 317; Asbestos in Union of S. Africa, A (12) 306.
Hall, E. E. Variation with temp. of thermal condy. of cast iron, A (8) 217.
Hall, R. F. Manuf. of glass articles, P (5) 145; Mach. for manuf. of glass articles, P (7) 191.
Hall, W. S. Application of elec. power in iron and steel indus., A (9) 233.
Hammond, G. T. See Hering, R.
Hanlon, J. H. and Wm. J. Gage glass, P (12) 334.
Hannan, J. R. Econ. production and use of steam, A (12) 304.
Hänse, W. War-time lime kiln, A (4) 108.
Hansen, O. I. Modified Orsat app. for flue-gas anal., A (10) 249.
Hardinge, H. Pulverizing anthracite coal, A (6) 154; Hardinge conical mill in ceram. indus., A (12) 302.
Harned, H. S. Activity coeff. and colligative properties of electrolytes, A (7) 175.
Harrassowitz, H. Bauxite deposits of Vogelsberges, A (5) 138.
Hart, L. H. See Berry, H. C.
Hartman, L. H. See Riffle, J. B.
Hartman, N. W. Glass-working mech., P (8) 216.
Hartmann, M. L. Carborundum refracs. in ht.-treating fur., A (2) 40.
Hartmann, M. L. and Koehler, W. A. Phys. charac. of specialized refrac., A (3) 67; Refrac. mat., P (3) 68.
Haslam, R. T. Keeping down fur. losses, A (12) 304.
Hastings, J. M., Jr. Modernize coke-oven plants, A (6) 154.
Hatch, A. G. Bldg. block, P (7) 185; App. for making concrete brick, P (12) 339.
Hauser, E. and Rie, E. Researches with a flame of exceptionally high temp., A (2) 41.
Havens, G. B. Waterproofing cement compn., P (11) 297.
Haws, W. H. Process and mach. for making bricks, P (12) 327.
Hayden, H. H. Mineral production in India, 1914–1918, A (5) 134.
Hayes, J. C. Waste-ht. boilers in steel plants, A (12) 304.
Heath, A. and Leese, A. Effect of calcination flints on earthenware bodies, A (3) 70.
Heaton, N. Preservation of stone, A (10) 244.
Hebberd, L. L. Burning of pulverized fuel in paper mill power plants, A (7) 174.
Hebden, G. A. See Lee, J. W.
Hedvall, J. A. and Heuberger, J. On a hitherto unknown copper aluminate of the spinel type, A (1) 6.
Hedvall, J. A. and Zweigbergk, N. v. Ht.-curve study of rapid low-temp. reactions: barium and oxides, A (4) 101.
Heidelberg, F. M. Santa Barbara 500-T. mill for concg. lead carbonate ores, A (7) 176.
Heike, W. Simple method for detn. of m. p. and critical temps., A (8) 202.
Helbig, A. B. Pulverization of fuels, A (10) 245.
Heller, H. Color standards, A (12) 322; Modified method for detection of tin, A (12) 310.
Henker, O. Mach. for angular grinding spectacle

glasses, P (7) 189; Mach. for grinding beveled rim surfaces on spectacle glasses, P (12) 332.
Henriot, E. and Mme. Double refraction of glass under press., A (4) 111.
Henshaw, S. B. Means for filling glass melting tanks, P (11) 291.
Hering, C. Suggestions concerning the college ed. of an engineer, A (12) 304.
Hering, R., Hammond, G. T. and Provost, A. J., Jr. Rept. of Comm. C-4 on clay and sewer pipe, A (3) 86.
Herrera, A. L. Diffusion in porous vessels, A (6) 161.
Herring, C. Electromagnetic motions in elec. fur., A (10) 254.
Hess, H. W. New Bergman gas and air valve described, A (3) 80; Action of metallic lead in pots, A (7) 186; A (9) 239; Action of iron and other metals upon clay and glass, A (9) 237; Care of glass melting pots, A (9) 237; Control of pot fur. conditions, A (9) 237; Proper control of pot fur. conditions, A (11) 287; Movement of molten glass in pots, A (12) 331.
Hesselman, B. O. W. and Meinhard, O. G. Mach. for producing hollow bricks, P (1) 17.
Hielscher. Crushing strength of whole and perforated brick, A (4) 117.
Highfield, J. S. Mining and purifying clay, P (4) 97.
Hill, C. R. Automatic mach. tests for setting time, A (2) 51.
Hill, C. R. See Seaton, M. Y.
Hill, E. C. Note on body cracking of terra cotta, A (2) 46, A (3) 85.
Hill, L. G. Fine grinding No. 2. Influence of shape of particle, A (1) 3.
Hirano, K. Process of mfg. talc pottery, P (11) 283.
Hirota, R. Decompn. of silicates, P (2) 38.
Hirsch, H. Osmosed clay, A (3) 58.
Hirt, J. F. Dry-kiln, P (1) 3.
Hisada, A. Artificial marble, P (11) 283.
Hisschemöller, F. W. Equilibria of permutites, A (2) 37.
Hobart, F. B. See Braley, S. A.
Hodkin, F. W. See English, S.
Hodkin, F. W. See Dimbleby, V.
Hodkin, F. W. and Turner, W. E. S. Relative advantages and disadvantages of limestone, burnt lime, and slaked lime as constituents of common glass batches contg. soda-ash and salt cake, A (12) 329.
Hodson, F. Stability of conducting (elec.) fur. hearth structures, A (4) 107.
Hoffmann, F. Temp. meas. in melting and annealing fur. in alloy indus., A (5) 133.
Hoffmann, O. Simplified stack calcns., A (8) 197.
Hojo, K. Clays of Mt. Hongo in Fukushima prefecture, A (11) 272.
Holborn, L. Temp. coeff. of elec. conductance of pure metals, A (7) 180.
Holdt, P. C. See Gardner, H. A.
Holland, C. E. Electrolysis, P (6) 162.
Holmberg, E. T. Ht. insulation, P (6) 158; Ht. insulating and resisting mat., P (7) 194.
Holmes, M. E. Outline of uses of lime, A (7) 193.
Honaman, R. K. See Silsbee, F. B.
Honaman, R. K. and Fonseca, E. L. Elec. resist. of various insulating mats. at high temps., A (1) 9.
Houldsworth, H. S. and Cobb, J. W. Reversible thermal expansion of silica, A (5) 141, A (12) 307.
Howe, J. A. Economic mineralogy, A (8) 202.
Howe, R. M. Discussion on disintegration of blast-fur. linings, A (7) 181.
Howe, R. M. See Barba, W. G.
Hudleston, L. J. and Bassett, H. Equilibria of hydrofluosilicic acid, A (1) 7.
Hugel, G. See Battegay, M.
Huges, W. Blue flame produced by common salt on coal fire, A (11) 269.
Hull, A. A. Refrac. in steel plant, A (4) 107.
Hull, C. See West, C. J.
Hull, R. W. Refrac. mat., P (11) 280.
Hull, W. A. and Crockatt, C. C. Rept. of Comm. C-10 on hollow bldg. tile, A (3) 87; Research is tool which will improve refrac., A (10) 251; Pyrometer possibilities, A (12) 306; Hollow bldg. tile, A (12) 323.
Hunt, M. H. Elec. porcelain research, A (11) 282.
Hunter, M. A. Thermocouple, P (7) 179.
Hurley, J. E. Glass-tank fur., P (1) 24.
Hutchins, O. Refrac. mats., P (4) 108.
Huth, F. Firing of painted glass, A (3) 78.
Hütter, C. Chromite in N. Macedonia, A (5) 138.
Hutton, E. S. Glass-discharging mechanism, P (1) 22; P (5) 146; Mach. for making hollow glassware, P (5) 146; Means for controlling discharge from glass tanks, P (12) 334.
Hyde, E. P. and Forsythe, W. E. Pyrometry. color temp. and brightness of various illuminants, A (7) 179.
Hyde, J. H. See Donkin, S.

Icenhour, A. A. Glass-plate manuf., P (7) 19.
Ihara, K. Ceram. mats. in Saga prefecture, A (11) 273.
Ikawa, M. Detn. of sulphate-, chloride-, carbonate-ions in soda-lime glass, A (9) 238.
Imhoff, W. G. Color classification of blast fur. slags, A (8) 201.
Ingersoll, L. R. Meas. gloss of paper; app., A (4) 98.
Ionescu, A. See Minovici, S.
Ionides, A. C., Jr. Improvement of fur. using gaseous fuels, P (4) 108.
Ipsen, C. L. Cost of ht.-treated parts reduced to minimum by elec. fur., A (10) 252.
Irion, E. New testing mach. II. Hardness testing mach., A (1) 4.
Irvine, E. See Taylor, A. B.
Ishikawa, J. Process of mfg. liquid gold, P (11) 269.
Ishikawa, K. Study of life of pots, used in round pot-fur., A (11) 287.
Ives, H. E. Proposed standard method of colorimetry, A (8) 211.

Jackson, F. P. Waterproofing natural stone, P (5) 150.
Jackson, L. E. Corrosion of producer-gas cooling system, A (7) 176.
Jäger, F. M. and van Klooster, H. S. Researches in chemistry of silicates, A (3) 62.
Jäger, G. Theory of Brownian movement, A (12) 311.
Jakob, M. Explanatory note on ht. insulating mats., A (10) 253.
Jaquerod, A. and Mugeli, H. Dielec. anomalies of silica glass, A (10) 257.
Jeffery, J. A. Ceram. insulating mat., P (8) 211.
Jenison, H. A. C. Manganese and manganiferous ores in 1920, A (5) 139.
Jenks, C. L. Indus. research and patents, A (7) 176.
Jenks, H. P. Kiln, P (1) 11.
Jessop, H. T. Cornu's method of detg. elastic constants of glass, A (4) 116.
Johannsen, A. Representation of igneous rocks in triangular diagrams, A (9) 231.
Johnson, H. E. Glass-cutting square, P (11) 292.
Johnston, H. G. Gas producer, P (10) 246.
Johnstone, S. Potash from feldspar, A (9) 230.
Jolig, H. Hot method of prepg. sand-lime brick bodies, A (4) 118.
Jones, C. H. Glimpses of Ohio ceram. indus., A (1) 3; A (2) 43; Enameled steel manuf., A (3) 83; Enamel-lined app., A (3) 83.
Jones, D. A. Investigation of refrac. mats.; after-contraction test, A (5) 141, A (11) 278; Standardization of after-contraction test, A (11) 278.
Jones, J. B. Sepg. compn. for plaster casts, P (8) 220.
Jones, L. and Westlake, Chas., Jr. Mat. for, and process of forming brick, tile, etc., P (1) 17.

Jones, L. W. Detachable puddle rod and blade, P (9) 226.
Jones, M. C. K. New graphic B. t. u. calculator, A (8) 201.
Jones, W. A. Cooling device for glass-drawing app., P (5) 147.
Jordan, W. J. See Elsenbast, A. S.
Joseph, R. Roofing-tile, P (5) 143.
Judson, L. C. and Martin, H. P. Elec. fur. in iron foundry, B (11) 280.
Junghandel, M. Artificial stone, P (4) 121.
Jungner, E. W. Hydraulic cement and alkali from natural silicates, P (4) 121.
Junk, H. See Ramann, E.

Kahr, A. App. for manuf. of hollow brick closed on all sides, P (8) 215.
Kallauner, O. and Fiser, J. Detn. of porosity and resist. of clay ware to acids, A (8) 212.
Kann, W. L. Abrasive for grinding and smoothing glass, P (1) 21, P (7) 184.
Kano, K. Process of decorating pottery, P (11) 283.
Kanoh, S. Accelerated test of Port. cement, A (6) 169, A (11) 295.
Karrer, E. Use of Ulbricht sphere in meas. of reflection and transmission factors, A (1) 15.
Katada, K. Process mfg. light brick, P (11) 286.
Kato, G. See Kawamoto, T.
Kaufman, C. F. Using clean cold producer gas, A (6) 158.
Kautzy, H. Some unsatd. silicon compds., A (3) 60.
Kavanagh, J. T. See Abrams, V. R.
Kawamoto, T. and Kato, G. Process of mfg. granite-porcelain, P (11) 283.
Kay, G. F. and Pearce, J. N. Origin of gumbotil, A (10) 249.
Keats, J. L. See Whitman, W. G.
Keele, J. Bentonite, A (9) 222; Mesozoic clays and sands in N. Ont., A (5) 137; Pottery clays in Can., A (11) 273.
Keeler, E. A. Method of operg. optical pyrometers, P (4) 115.
Keen, B. A. and Raczkowski, H. Reln. between clay content and phys. prop. of soil, A (6) 171.
Keen, W. H. Elec. fur. melting, A (10) 253.
Keifer, J. E. Brick or bldg. block, P (1) 18.
Keinath, G. New optical pyrometer for high temps., A (5) 132.
Kent, J. Production of bores in glass, P (1) 23.
Keppler, F. L. Glass pavement-light, P (1) 24; Glass construction unit, P (1) 25.
Kerner-Marilaun, F. E. Adriatic bauxite, A (12) 317.
Kerr, C. H. Aspects of science applied to glass indus., A (9) 236.
Kershaw, J. B. C. Elec. fur. in melting and refining, A (6) 163.
Kestner, P. Filling mat. for use in Glover towers and similar app., P (6) 160.
Ketson, T. B. Glass manuf., P (6) 167.
Kinzinger, F. J. Multiple brick mold, P (7) 193.
Kirchner, R. E. New uses for zirconium, A (11) 275.
Kirk, C. J. Firing earthenware, P (11) 284.
Kishimoto, K. Study of gypsum, A (11) 295.
Kitamura, Y. Reln. between silica, alumina and basic oxides in porcelain glazes fired at high temp., A (6) 164; On ratio of Al_2O_3 and SiO_2 to RO in porcelain glazes fired at high temps., A (11) 281.
Kjellgren, B. See Sieurin, E.
Klein, A. A. Constitution and hydration of Port. cement, A (12) 338.
Klein, A. A. See Purdy, R. C.
Kleinlogel, Dr. Acid-proof cements, A (3) 88.
Klinkmüller, J. Artificial paving blocks, A (2) 51.
van Klooster, H. S. See Jäger, F. M.
Knapp, L. F. Soly. of small particles and stability of colloids, A (11) 275.
Knight, F. P. and Shimmin, J. T. Sepg. feldspar and quartz (hydraulic concn.), P (6) 158.
Knight, N. See Reed, B. B.
Knipp, C. T. High-speed high-vacua mercury vapor pumps, A (8) 200.
Kobayashi, K. Jap. acid clay (fullers' earth), its props., chem. applications and reln. to geol. formation of petroleum, A (7) 180.
Koch. Bldg. blocks made from boiler scale, A (3) 85.
Koch, H. Utilization of slag: Manuf. of slag bldg. brick, A (2) 46.
Koehler, W. A. See Hartmann, M. L.
Kohl, H. Influence of small amts. of electrolytes on stability of clay suspensions and use in purification of clay, A (11) 266.
Kohn, S. Theory of water-gas porcelain, A (5) 131.
Kojima, K. See Amenomiya, Y.
Kolthoff, I. M. Electro adsorpn. as a purely chem. phenomenon, A (8) 203.
Koon, S. G. Adaptable elec. steel company, A (10) 252.
Koppers Co. Gas. manuf., P (6) 158.
Kosmann. Slaking of lime, A (2) 52.
Kowalke, O. L. Brady B. t. u. indicator tests, A (8) 201.
Kr. Brick conveyors, A (4) 117.
Krak, J. B. Some calcn. of glass tech., A (3) 73; Compn. of opaque glass, A (3) 77.
Kramer, E. Elec. enameling oven, A (6) 169.
Kramer, F. J. Bldg. block, P (4) 122.
Krarup, C. Successful recovery of potash as by-product from cement kiln, A (7) 192.
Krase, H. J. Simple formula for calcn. of sp. ht. of solids, A (9) 232.
Kraze, F. Zirconium fluoride glazes, A (11) 281.
Krebs, W. Hydraulic setting properties of basic blast-fur. slags, A (12) 338.
Kregelius, L. M. Water-proofing cement, P (3) 93.
Kreisinger, H. Importance of air supply in combustion of coal, A (2) 42; A (3) 66.
Krieger, B. Neuss and sand-lime brick works, A (4) 118; Lime and sand-lime indus., A (4) 118.
Kröger, M. Influence of tungstic acid on gelatinization of silicic acid in strong hydrochloric acid soln., A (8) 203; Prepn. of soln. of silicic acid and tungsten hydroxide with help of Hildebrand cell, A (8) 202.
Krogh, S. A. S. and Pederson, P. H. Analyzing gases, P (4) 99.
Kroha, G. F. Glass-lined tanks, A (10) 259.
Kropf. Use of slag cement in construction work, A (12) 338.
Kruss, M. Short and long flames in gas firing, A (3) 66.
Kucera, P. Ring mold for glass presses, P (11) 292.
Kühl, H. German sources of silica useful in glass indus., A (3) 73; Lime-silica-iron oxide, A (12) 338; Superior cements, A (3) 88.
Kunzler, J. W. Method of casting plate-glass and app. therefor, P (5) 147.
Kuppers, K. Method and app. for forming glass tubes, P (5) 147.

Ladd, J. B. Method and means for brick hacking, P (12) 326.
Ladoo, R. B. Bentonite, A (3) 87; A (6) 156; Garnet, A (10) 255.
La France, R. Mech. for transferring glassware, P (11) 293.
Laird, J. S. See Riddle, F. H.
Lamme, B. G. Suggestions concerning college ed. of an engineer, A (12) 304.
Lamour, H. and Stevenson, W. C. Ht. efficiency increase in cement burning, A (5) 150.
Landis, W. S. Geog. of electrochemistry, A (11) 269.
Lang, R. New iodometric method for detn. of copper, A (8) 205.
Langmuir, I. Chem. reactions on surfaces, A (12) 310.
Lanquine, A. See Bertrand, E.
Lapp, G. W. Prepg. clay for making ceram. ware, P (12) 322.

Lapp, J. Method and mach. for forming impressions in plastic articles, P (7) 193.
Larsen, A. Rotary kiln for sintering cement slurry, etc., P (4) 121.
Larsen, E. S. and Foshag, W. F. Merwinite, new calcium magnesium orthosilicate from Crestmore, Calif., A (7) 180.
Lea, F. C. Effect of temp. on some props. of mats., A (2) 52.
Lechat, E. App. for manuf. of brick or bldg. blocks, P (1) 18.
Lecher, O. Utilization of red slime, A (2) 31; Pyrex glass, A (12) 331.
Lee, J. W. and Hebden, G. A. Amer. coking practice, A (8) 209.
Leese, A. See Heath, A.
Le Guen. Aging of ground clinker, A (8) 218.
Lemmon, J. H. Kiln for burning lime or cement, P (6) 172.
Lemon, J. J. Mortar and bldg. block compn., P (11) 297.
Lesley, Robert W. Cement, A (3) 91.
Levy, L. Automatic recording and analytical app., A (5) 132.
Lichte, H. Modern Pintsch-generator gas plant and results of opern. with different fuels, A (5) 130.
Lidstone, F. M. Meas. of abs. viscosity, A (8) 198.
Liempt, J. A. M. v. Note on green color of tungsten trioxide WO_3, A (7) 180.
Lindenberg, F. H. Centrifugal separator, P (6) 159.
Lindley, W. Recent visit to some Spanish and Portuguese potteries, A (3) 70.
Lindroth, G. T. Graphite ore deposits in Norberg Berslag, A (2) 37.
Lininger, H. Surface combustion, A (5) 140.
Little, A. D. Dependence of lime indus. upon nature and science, A (3) 91.
Little, G. M. Elec. htd. forging and ht.-treating fur., A (6) 163.
Lloyd, S. L. Prepn. of fullers' earth in Fla., A (5) 128.
Lohrey, W. Elec. fur., P (5) 133.
Longyear, R. D. Diamond-drill sampling method, A (5) 136.
Lorenz, C. F. Frosted glass and process for making same, P (1) 22.
Lorenz, E. H. and Peiler, K. E. Glassware ejecting mech., P (7) 189.
Lorenz, R. and Haegermann, G. Equilibrium between Port. cement and limewater, A (1) 26.
Lormand, C. See François, M.
Lotka, A. J. General conditions of validity of principle of Le Chatelier, A (8) 204.
Lott, C. R. Means and method for producing charges of molten glass, P (1) 23; Method and app. for making glass articles, P (2) 49.
Loughlin, G. F. and Coons, A. T. Lime in 1919, A (3) 91; Lime in 1920, A (4) 120.
Lowry, F. S. Ceram. vessel, P (7) 177.
Lowry, T. M. and McHatton, L. P. Comparative study of methods used for meas. of color, A (10) 256.
Lucas, R. D. Filter press with rotary filter, P (10) 256.
Luce, G. E. Process of mfg. and handling brick, P (1) 18; Revolving crane for brick handling, P (1) 18.
Ludwig, H. Incinerator for mill refuse made of brick and concrete, A (5) 129.
Lund, J. Purifying molten slag, P (4) 121.
Lux, E. Possibility of prepg. high-grade silica brick from quartzite, A (3) 67.
Lynch, J. W. Ware steadier for glass-working mach., P (7) 190.
Lytle, W. J. See Milner, E. E.

McAdams, W. H., and Frost, T. H. Ht. transfer, A (8) 203.
McCann, H. P. Fur. and method of conveying mats., P (7) 182.
McCarthy, T. V. See Young, R. B.
McClelland, E. H. Instruction of students in use of tech. lit. unexploited phase of eng. ed., A (10) 246.
McCoy, J. P. A. Plastic compn. and articles formed therefrom, P (12) 305.
McDonald, D. N. Daylight glass, P (7) 188.
McDougal, T. G. Burning ceram. wares, P (12) 305; Burning ceram. wares and app. therefrom, P (12) 305.
McDougall, A. Gas-fired pottery kiln, P (12) 305.
McGee, F. R. and Vreeland, G. W. Dry gas-cleaning tower, P (7) 183.
McGee, R. T. Glass-delivery app., P (5) 146.
McGuigan, H. A. Liesegang ring formation, A (6) 161.
McHatton, L. P. See Lowry, T. M.
McKelvey, J. H. and Ryan, C. F. Process of making plate-glass, P (5) 148.
McNicholas, H. J. See Gibson, K. S.
McSwain, Wm. H. App. for manuf. of glassware, P (1) 24.

MacDonald, R., Jr. See Richmond, H. A.
Macheleidt. Volumetric estn. of potassium, A (12) 310.
Mackowsky, H. Schinkel's Berlin brick bldgs., A (8) 213.
Maetz, O. Elec. fur. for melting glass, A (3) 66.
Maitland, A. G. Magnesite, A (3) 62.
Malloch, E. S. See Blizard, J.
Manchot, W. and Funk, H. Form of silicon; Soly. of silicon in hydrofluoric acid, A (8) 206.
Manegold, R. A. Magnetic sepn. in glass plants, A (9) 237.
Mannebach, O. New comparison app. for colorimetric detn., A (6) 159.
Marani, V. G. See Emley, W. E.
Marckworth, O. S. Method of producing non-shatterable glass, P (12) 332.
Marconet, O. P. and Carter, W. O. Sheet-glass drawing mach., P (5) 148.
Marden, J. W. and Rich, M. N. Invest. of zirconium with especial ref. to the metal and oxide, A (3) 67.
Marino, Q. Metallizing pottery and glass, P (8) 217.
Marlow, J. H. The Marlow gas-fired tunnel oven, A (12) 301.
Marris, F. M. Kiln fur., P (7) 183.
Marsh, F. W. See Scales, F. M.
Marsh, K. Setting recording pyrometer for cold-junction temp., A (7) 179.
Marston, A. and Stewart, J. T Rept. of Comm. C-6 on drain tile, A (3) 86.
Martin, F. Control of combustion in fur., A (5) 131.
Martin, H. P. See Judson, L. C.
Martin, R. F. Wall construction and brick therefor, P (7) 185.
Martinet, Jh. See Barlow, J.
Martinoff, W. Abrasive, P (5) 143.
Marzetti, C. See Parravano, N.
Mascard, L. Utilization of liquid fuels in Hoffmann kilns, A (6) 155.
Masson, I., Gilbert, L. F. and Buckley, H. Suggested method for detn. of abs. viscosity of molten glass, A (12) 328.
Mather and Platt, Ltd. See Cartner, A. T.
Matheson, J. H. Cleaning producer gas without washing, A (9) 233.
Mathiesen, W. Manuf. of carbon arc electrodes, P (6) 159.
Mathy, M. App. for htg. by combustion without flame, P (1) 11.
Matsuo, K. Glass roll, P (5) 146; Glass-covered steel rolls, P (7) 188.
Matsuo, S. Cement, P (4) 122.
Mattison, R. V., Jr. Asbestos cement bldg. mat., P (4) 122.
Mauge, L. Modern app. for control of combustion and htg., A (8) 201.
Meade, A. Some practical considerations with handling plant, A (8) 196.
Meade, R. K. Lime kilns and lime burning, A (1) 26; Critical rev. of the wet process for manuf. of Port. cement, A (2) 52; Port. cement, B (2) 54; Kiln, P (11) 279.

Meinhard, O. G. See Hesselman, B. O. W.
Mellor, J. W. Plasticity of clays, A (2) 36; Thorpe's soly. ratio, A (3) 70; On plasticity of clays, A (11) 284; Unestimated losses in pottery manuf.—Works blindness, A (1) 12; Plea for toleration in art (Symposium on art), A (1) 16.
Mellor, J. W., Sinclair, N. and Devereaux, P. S. Dehydration of dried clays, A (11) 285.
Menke, P. O. Disintegration of blast-fur. linings, A (7) 181; (Blast-fur.) lining failures caused by zinc, A (10) 253.
Merwin, H. E. See Bichowsky, F. R. v.
Metallbank und Metallurgische, Akt. Ges. Zinc oxide, P (6) 162.
Meyers, S. L. Possibilities of fusion process for cement production, A (12) 337.
Michel, W. G. Carbon electrodes; abrasives, P (9) 234.
Middlemiss, C. S. Econ. minerals of Idar State (India), A (5) 134.
Middleton, A. H. Silica brick for coke ovens, A (4) 107.
Middleton, G. N. See Stuart, A. T.
Miles, J. Spit-out of glazes on passing through enamel kiln, A (12) 319.
Miller, L. B. See Pearce, J. N.
Miller, T. F. Manuf. of Port. cement, A (11) 296.
Miller, W. J. Mech. for forming glassware, P (7) 190; Process and app. for feeding glass, P (11) 292.
Milligan, L. H. Mech. of dehydration of cryst. aluminium hydroxide and of absorpn. of water by resulting alumina, A (10) 250.
Milliken, J. A. Art of ornamenting glass articles, P (5) 147; Glass-cutting mach., P (7) 190.
Milner, E. E. Annealing of glassware—past, present, future, A (3) 76.
Milner, E. E. and Lytle, W. J. Plate-glass annealing leer, P (12) 333.
Milner, R. and Robinson, T. Bricks, P (3) 87.
Milton, T. Suggestions concerning college ed. of an engineer, A (12) 305.
Mimura, S. and Yamamoto, R. Magnesia plaster, P (1) 27.
Minor, E. L. Brick-cleaning mach., P (5) 144.
Minovici, S. and Ionescu, A. "New method for volumetric detn. of copper, A (8) 203.
Mock, H. E. Human waste in indus., A (2) 32.
Moeller, M. Elec. carbon dioxide recording instrument, A (6) 159.
Moeller, R. Recording combustible gases, A (5) 133.
Mollen, J. F. and Patnoe, W. W. Fur. lining, P (4) 109.
Momoki, S. How to prevent smoke from pottery kilns, A (11) 282; On tunnel kilns, A (11) 277.
Momotani, M. Drying app., P (7) 179.
Monasch, E. Titration of zinc, A (12) 310.
Moody, H. N. Viscosimeter, P (7) 179.
Moore, B. Wad clay, A (1) 12; Elutriation test for potters, A (3) 65.
Moore, B. J. Some notes on saggers, A (3) 71.
Moorshead, T. C. Glass manuf., P (2) 49.
Morey, G. W. Glass tech., A (12) 331.
Morgan, P. G. Graphite in New Zealand, A (9) 228; Talc in New Zealand, A (9) 228; Clay and fullers' earth in New Zealand, A (9) 228.
Mori, S. Effect of variation in compn. of ground-coat enamel on its adherence to iron, A (11) 293; Study of vehicles used in enameling slip, A (11) 293.
Morimoto, K. Rept. of expts. on producer-gas, A (11) 267.
Morota, T. Fur. for mfg. tile, P (2) 47.
Morrison, M. L. Refrac. source of troubles, A (8) 209.
Morton, J. and H. Gas-fired continuous kilns, P (6) 164.
Moser, T. Appliance for throwing mortar for plastering of walls, P (12) 339.
Mott, W. R. Compn. for producing coatings on refrac. articles, P (12) 316.
Mount, L. L. Glass-melting fur., P (5) 147.
Mugdan, S. See Ruff, O.
Mugeli, H. See Jaquerod, A.
Mühlen, L. von zur. Recently developed magnesite deposits in Galgenberge, Silesia, A (5) 138; Kaolin and kaolinized granite in dist. between Strobel and Saarau, Silesia, and their formation, A (10) 248.
Muirhead, C. M. M. See English, S.
Mulholland, V. Closure for molten glass-outlets, P (12) 332.
Müller, Fr. Stoneware machs., pumps, and exhausters, A (3) 71.
Münch, S. Question of liquefaction of carbon, A (2) 40.
Murakami, T. Equilibrium diagram of iron-silicon system, A (2) 35.
Murakoshi, E. Process of forming clay image, P (11) 284.
Murray, H. D. Coagulation of colloids by electrolytes, A (5) 136.
Myers, H. A. Method and app. for making glass, P (11) 291.
Myers, S. L. Reln. of carbon dioxide and moisture to setting time of cement, A (2) 50.
Myers, T. L. Drier for use in manuf. of articles from tender clay, P (7) 185.
Mylius, F. Alkalimetric testing of glassware, A (3) 79.
Myott, A. Some unsolved probs. in potting, A (3) 70.

Nakahara, S. Present condition of ammonia-soda indus. in Jap and its future, A (11) 268.
Nakazawa, Y. See Yunoki, S.
Narbutt, J. Reduced temps. of transition and fusion, A (8) 204.
Naske, C. Mill for colloidal comminution in indus. chem. work, A (2) 34.
Nathanson, J. B. Coloration of glass by ultra-violet light, A (12) 331.
Needham, H. Elec. fur. melting, A (10) 252.
Neese, O. V., F. L. and E. C. Superlocking hollow tile, P (12) 327.
Nelson, J. Port. cement and calcining kiln, P (2) 54; Concrete-tie-making mach., P (7) 194.
Nettleton, S. Sepg. solid mats., P (9) 226.
Neuhausen, B. S. and Patrick, W. A. Organogels of silicic acid, A (5) 135.
Neville, H. A. See Taylor, H. S.
Newberry, S. B. Cement clinker and by-products, P (4) 122; Basic refrac. brick, P (5) 142; P (7) 182.
Newland, D. H. Garnet, A (3) 65; Mineral resources of state of N. Y., A (3) 65.
Newman, H. S. Contraction of some quaternary (ceram.) mixts. fired to different temps., A (3) 59.
Nicholas, H. O. See Weiser, H. B.
Nicolardot, P. Historic optical glasses, A (7) 186.
Nitzche, H. Behavior of cement mortars in sulphate-bearing waters, A (2) 50; Protection of concrete and cement against action of sulphates by means of barium carbonate, A (6) 170.
Noll, C. Plaster compn., P (7) 193.
North, C. L. Improved continuous-opern. pot lime kiln, A (11) 297.
Nôtomi, S. Rept. on clay resources for Soma wares, A (11) 273.
Nutting, P. G. Study of elastic viscous deformation, A (3) 64.

O'Brien, G. L. Plant manager and chemist, A (11) 268.
Odelberg, A. S. W. Further recent improvements in Swedish potteries, A (3) 71; New appliances in potting, A (1) 12.
Odell, W. W. Coal and coke mixt. as water-gas generator fuel, A (6) 156.
Odén, S. Clay as dispersed systems, A (11) 275.
Office, L. R. Lab. fur. for deformation temp. of refrac., A (8) 209.
Ogawa, I. Process of fixing tack to artificial tooth, P (11) 284.
Ogawa, T. Study of chem. glassware, A (11) 290.
Ogden, E. P. Tunnel kiln, P (12) 305.
"Omega." Constant-temp. baths, A (2) 33.

O'Neill, F. Glass-flow-off controller, P (11) 291.
Ormandy, W. R. Liquid, colloidal and powdered fuels, A (4) 97.
Osmond, C. R. See Abrams, V. R.
Ostwald, W. Theory of gasification process, A (4) 106.
Ota, H. See Amenomiya, Y.
Ottman, R. E. Elec. insulation, P (11) 269.
Owens, M. J. Sheet-glass forming app., P (5) 147.
Owens, T. S. App. for drawing sheet glass, P (1) 22.

Padoa, M. Studies on sp. hts. (III), A (9) 231.
Paetsch, W. See Rieke, R.
Painter, A. E. See Dobbs, C.
Papot, J. A. Brick, P (5) 143.
Parkert, O. New method of coating pearl beads, A (3) 72; Polishing glass by means of acids, A (6) 166.
Parmelee, C. W. Fullers' earth deposit at Olmstead, Ill., A (7) 176; Use of stain in bodies, A (12) 321.
Parmelee, C. W. and Schroyer, C. R. Illinois fire clays, A (12) 316.
Parodi-Delfino, B. Cements, P (6) 172.
Parr, S. W. See Austin, M.
Parsons, C. A. See Donkin, S.
Patch, W. E. Proc. of removing enamel from enameled metal articles, P (12) 335.
Patee, F. Compn. for bldg.-blocks, P (11) 297.
Patnoe, W. W. See Mollen, J. F.
Patrick, W. A. See Neuhausen, B. S.
Patrick, W. A. and Grimm, F. V. Ht. of wetting silica gel, A (5) 135.
Pauli, W. See Adolf, M.
Parravano, N. and Mazetti, C. Transformation of light magnesia into dense form, A (1) 25.
Payne, S. H. See DeLany, E. H.
Pearce, J. N. See Kay, G. F.
Pearce, J. N. and Miller, L. B. Some colloidal properties of Pleistocene clays and their bearing on chem. theory of formation of gumbotil, A (10) 249.
Pearson, A. Zinc oxide, P (10) 251.
Pearson, J. C. Shrinkage of Port. cement mortars and its importance in stucco construction, A (4) 120.
Pease, R. N. Sizes of atoms in crys, A (9) 231.
Peaselee, W. D. A. High tension insulator porcelain, A (4) 111.
Pecover, P. C. See Smart, B. J.
Peddle, C. J. Nomenclature of glass, A (1) 20; Comparison of alkali-lime-silica and alkali-lead oxide-silica glasses, A (1) 20; Development of various types of glasses, A (3) 81; Manuf. of optical glass, A (4) 111; Interaction of silica, sodium oxide and barium oxide, A (6) 165; Interaction of silica, potassium oxide and barium oxide, A (6) 165; Comparison of alkali-barium silicate and alkali-lead silicate glasses, A (6) 166; Comparison of alkali-barium oxide-silica glasses, A (6) 166; Interaction of silica, barium oxide, and oxides of sodium and potassium, A (6) 166; Effect of joint presence of sodium and potassium on soly. of lead glasses. The development of various types of glass (XI), A (12) 329.
Pederson, P. H. See Krogh, S. A. S.
Peek, F. W., Jr. Insulation of high-voltage transmission lines. Conception of million volt line, A (7) 184.
Peiler, K. E. App. for feeding molten glass, P (7) 189.
Peiler, K. E. See Lorenz, E. H.
Peirce, T. W. Twin wall brick, P (8) 215.
Pelka, O. Chinesisches Porzellan, B (2) 45.
Perry, A. M. Fuel economy and produc. expenses, A (12) 304.
Peters, R., Jr. Eastern Steel Co. new blast fur., A (7) 181.
Petts, E. Knacks in setting up-draft kilns, A (11) 277; Burning in coal-fired Dutch kiln, A (8) 214.
Pfleiderer, W. Boiler applicable for use as absorber in absorpn. refrigerating machs., P (5) 133.
Philipon, H. J. F. Furs., P (4) 108.
Phillips, F. J. and Rose, E. G. Alkali silicates, P (1) 3.
Phillips, F. J. Sol. silicates, P (3) 65.
Phillips Lamp Works. Glass manuf., P (6) 167.
Pieters, I. S. One-piece fur. lining, A (12) 314.
Pilkington, A. C. and Gaskill, J. App. for gathering glass from molten mass, P (12) 333.
Pink, M. Glass cutting, A (3) 78.
Plant, H. J. Pottery design from mfgr.'s point of view. (Symposium on art), A (1) 17.
Plasz, L. Elec. dust pptn. and gas purification. (Cottrell process), A (6) 161.
Platzmann, C. R. Addn. of trass to cement, A (2) 50; New centrifugal filter-press, A (1) 5; A (2) 33; "Gee-system," a new procedure for sepn. of solid mats. from liquids, A (6) 154.
Plowman, W. W. See Feldenheimer, W.
Plusch, H. A. Some causes of so-called disintegration of terra cotta brick, and allied ceram. mat. and suggested remedies, A (2) 46; A (3) 85.
Poche, R. Chemico-tech. and mech. testing of caustic magnesite, A (7) 191.
Poetsch, I. W. See Riche, R.
Pokorny, J. T. Brick-kiln construction, P (1) 17.
Polayni, M. Röntgenographic detn. of crys. arrangement, A (11) 271.
Pollacsek, E. Process for manuf. of briquettes, P (8) 215.
Pollitt, A. A. Colloidal state and terminology, A (4) 104.
Poste, E. P. Enameled products research lab., A (3) 85; A (7) 191.
Potter, S. J. Plaster support for walls, P (12) 339.
Potts, H. E. Influence of patent law on evolution of research, A (10) 246.
Poulson, A. and Rourke, C. J. Foundry sand, P (8) 199.
Powell, E. B. Pulverized coal as fuel, A (6) 156.
Prausnitz, P. H. Electroösmosis, A (8) 198.
Prentiss, F. L. Enameling cast-iron and steel mats., A (7) 191.
Primrose, J. How ht. losses in chem. plants may be reduced, P (5) 131.
Pring, J. Elec. fur., B (2) 42.
Pritchard, G. A. See Buckman, H. H.
Pritchard, G. A Zircon spark plug porcelain, A (12) 321.
Provost, A. J., Jr. See Hering, R.
Pulfrich. Transition of quartz into tridymite, A (3) 60.
Purdy, R. C. Benefits of tech. and scien. research, A (11) 266.
Purdy, R. C., Beecher, M. F. and Klein, A. A. Refrac. article of magnesia and alumina, P (7) 183.
Purdy, R. C. and Fulweiler, W. H. Rept. of Comm. C-8 on refrac., A (3) 66.
Pye, D. R. See Donkin, S.

R. Gypsum as a substitute for limestone in glass batch, A (3) 78.
Rabe, H. Modern filtering app., A (2) 33.
Raczkowski, H. See Keen, B. A.
Raeder, B. Zinc-smelting fur., P (5) 142.
Raman, C. V. Mol. structure of amorphous solids, A (7) 175.
Ramann, E. and Junk, H. Basic exchange in silicates, A (3) 61.
Rambush, N. E. Comparison between lab. fuel tests and practical working results of producer-gas process, A (7) 176.
Ratcliff, W. W. Glass cutter, P (7) 190.
Rathgen, F. Contributions to history of chem. arts, A (6) 155.
Ratliff, W. C. and Davis, J. D. Sepn. of mineral matter from natural flake graphite, A (4) 107.
Ravner, O. See Goldschmidt, V. M.
Rayleigh, Lord. Double refraction and cryst. structure of silica glass, A (3) 79.
Raynaud, A. Comments on various methods of attacking mineral ochers, A (5) 138.
Rebuffat, O. Silica brick of constant vol., A

(8) 207; Refrac. silica brick and process of manuf., P (12) 316.
Reed, B. B. and Knight, N. Some Amer. dolomites, A (2) 37.
Rees, W. J. Notes on Amer. practice in refrac., A (11) 277; Specif. for glass refrac. mats., A (12) 330.
Reese, C. L. Informational needs in science and tech., A (10) 245.
Reese, C. L. and Wadhams, A. J. Indus. benefits of research, A (2) 32.
Reid, A. E. Elec. furs., P (8) 210.
Reid, J. H. App. for making carbides, A (2) 43.
Rengade, E. and Desvignes, E. Method for detn. of hardness of refrac. mats. at high temp., A (2) 39; Hardness of refrac. at high temp., A (5) 139.
Reutlinger, E. Ht. saving invest. on kilns, A (4) 106; Practical economies in firing pottery, A (4) 106; Ht. conservation studies on kilns, A (8) 214; Firing of porcelain in tunnel- and round-kilns, A (11) 280.
Rhead, T. F. E. Chemistry and physics of gas works refrac., A (9) 233.
Rhonemus, C. A. Sheet glass-drawing mach., P (1) 22; Sheet glass-drawing app., P (1) 22.
Rhonemus, C. A. See Callard, R. P.
Ri. Volatilization of silica in manuf. of refrac. in elec. fur., A (12) 312.
Rich, H. Cement compn., P (6) 171.
Rich, M. N. See Marden, J. W.
Richards, W. E. W. Plastic cement mixt., P (8) 220.
Riche, R. and Poetsch, I. W. Soly. of coloring metal oxides in china glazes, A (12) 318.
Richey, W. F. Brick-scoring mech., P (12) 326.
Richmond, H. A. and MacDonald, R., Jr. Artificial corundum, P (10) 255.
Riddle, F. H. and Laird, J. S. Method of detg. tensile strength of porcelain, A (3) 69.
Rie, E. Influence of surf. tension on fusion and solidification, A (1) 7.
Riedel, F. Device for dry granulation of slag, P (5) 150.
Rieder, W. Effect of temp. upon ultra-violet absorpn. of glasses, A (6) 165; A (7) 187.
Rieke, R. Rational anal. as plant control, A (8) 214; Quartz and flint in Amer., A (12) 311.
Rieke, R. and Gary, M. Testing of porcelain, A (8) 211.
Rieke, R. and Paetsch, W. Constitution of ceram. coloring mats., A (11) 284.
Riffle, J. B. and Hartman, L. H. Kiln, P (8) 199.
Ringrose, H. T. Scien. control of combustion, A (1) 4.
Rishkevich, E. Liquefaction of carbon, A (4) 102.
Ritchie, H. C. Water-tightness of concrete structures, A (12) 335.
Roadhouse, R. Fur. for enameling ceram. ware, P (5) 131.
Roark, R. J. Phys. properties of magnesia cement and magnesia cement compds., A (1) 26.
Roberts, H. S. Fur. temp. regulator, A (4) 98.
Roberts, M. Floor-coverings, P (2) 54.
Robertson, W. F. Fire brick manufd. at Clayburn, Brit. Columbia, A (9) 227; Fluorspar in Brit. Columbia, A (9) 229.
Robson, H. C. Brick-making in remote mining dists., A (8) 201.
Rogers, A. F. New occurrence of cristobalite in Calif., A (9) 230; Collophane, much neglected mineral, A (10) 256.
Rolboul, M. de. Making films of silica, alumina, etc., P (4) 108.
Rona, P. and György, P. Studies on sedimentation, A (4) 100.
Roost, H. J. Can. Inst. of Chemistry, A (11) 267.
Roscoe, H. Suggestions for standardization of geol. sections of strata proved in boreholes, shafts, etc., A (5) 135.
Rose, C. C. See Cox, O. M.
Rose, E. J. See Phillips, F. J.
Rossiter, E. C. and Sanders, P. H. Prepn. of zirconia from Brazilian ore and new method of detn., A (7) 181.
Rourke, C. J. See Poulson, A.
Rowart, E. App. for manuf. of glass in continuous sheets, P (11) 291.
Rowley, C. A. See Crowley, J. E.
Rowlinson, F. Indus. electroösmosis, A (2) 36.
Ruff, O. Prepn. of refrac. bodies for temps. over 2000° in fur. with reducing atmospheres, A (9) 233; A (9) 234.
Ruff, O. and Mugdan, S. High temp. studies, etc., A (3) 60.
Ruff, O. and Schmidt, P. Vapor press. of SiO_2, Al_2O_3, CaO and MgO, A (1) 9.
Rule, J. F. Method and means for forming and transferring gobs of molten glass, P (11) 290.
Rummel. Probs. in ht. economy (in Germany), A (4) 97.
Ruppel, F. C. Coating cement with celluloid, P (3) 92.
Ryan, C. F. See McKelvey, J. H.
Ryan, J. H. Process for treating clay, P (1) 3.
Ryther, H. A. Glass cutter, P (12) 333.

S. Blisters on sewer pipe, A (12) 325.
S. E. Firing of stoneware, A (3) 69.
Sa. Reln. between d. and chem. compn. of glasses, A (1) 19.
Sa. H. Firing with artificial draughts, A (4) 106
Saar, R. Pycnometer d. detns., A (11) 270.
Sachse, H. Firing temps. attainable with wood, A (4) 108.
Said, J. M. Obtaining glass, P (12) 334.
St. Austel. Colloidal clay production, A (10) 247; China clay, A (12) 308.
Salpeter, J. Strains in unannealed glass, A (4) 115.
Sampelayo, P. H. Aluminium, A (8) 209.
Sampson, E. Chromite in 1921, A (10) 254.
Samuelson, A. Conveyor for htd. glassware, P (11) 292.
Sanders, A. J. Artificial stone, P (5) 150.
Sanders, A. J. and L. A. Coloring cement surfaces, P (4) 121.
Sanders, P. H. See Rossiter, E. C.
Sandstrom, C. O. Excess air in cement kilns, A (12) 337.
Sasse. Influence of mortar on wall strength, A (4) 118.
Sauer, U. Handling equipment, A (8) 211.
Sauvageon, V. M. Radiation elec. glass fur., A (9) 236; Elec. fur., A (11) 279.
Scales, F. M. and Marsh, F. W. Tyndallmeter reading of soil dispersoids, A (3) 60.
Schaffer, J. C. Burning lime, P (3) 92.
Schaffer, J. C. See Crow, W.
Scheel, K. Thermal expansion of some subs. (I), A (2) 36.
Scheid, J. F. and Weicker, W. Proper design of porcelain insulators, A (9) 235.
Scheuerle, H. A. Method of making bifocal lenses, P (1) 22.
Scheumann, K. H. Water content of heulandite, A (2) 35.
Schiff, S. Dental cement, P (8) 220.
Schlegell, F. v. Elec. arc fur., P (9) 234.
Schliebs, G. Packing of Gay-Lussac towers, A (4) 111.
Schlieffer, H. Surf. tension of colloidal solns., A (11) 274.
Schmidt, H. Connection between viscosity and chem. constitution of gases, A (8) 215.
Schmidt, L. Sandwasher, A (2) 34.
Schmidt, M. Whiteware glaze defects and their prevention, A (1) 14.
Schmidt, P. See Ruff, O.
Schneider, P. Unburned fireproof blocks, A (3) 66.
Schneider, W. G. Automobile-headlight glass, P (1) 21.
Schnurpfeil, P. K. E. Pot and block room, A (3) 79.
Schoeller, W. R. Note on product and testing of zirconia, A (8) 198.
Scholz, F. Artificial drying of brick, A (2) 46.

Schöne, O. Reconstruction of grates for firing with lignite and briquettes, A (4) 107.
Schott, Crystn. and transposition phenomena in hardening of cement, A (8) 219.
Schott, E. High-frequency losses in glasses and other dielecs., A (4) 115; Ht. saving in revolving kilns, A (4) 108.
Schott, F. Crystn. procs. and transformation in hardening of Port. cement, A (3) 91.
Schott, O. Works management in cement factory, A (4) 118.
Schreiner, E. New conceptions of electrolytes, A (10) 249.
Schrieber, E. Manuf. of fireproof mats. and their uses, A (2) 40.
Schroyer, C. R. See Parmelee, C. W.
Schudi-Freuler, P. Glass manuf.; elec. insulation, P (6) 167.
Schuen, W. Method of burning salt glazed ware, A (3) 59; Firing stoneware pipes, A (4) 111.
Schulz. War experience with refrac. bricks in Ger. army, A (4) 107.
Schulze, H. See Wartenberg, H. v.
Schumacher, E. E. Plastic compn., P (12) 338.
Schurecht, H. G. Use of electrolytes in purification and prepn. of clays, A (9) 234.
Schwaner, J. M. Cleansing and polishing paste for glass, P (3) 82.
Schwarz, R. Studies on gel of silicic acid, A (4) 102; On binary systems of lithium orthosilicate with zirconium and calcium orthosilicate, A (1) 6.
Schwarz, R. and Bausch, H. Introduction of silicic acid into nucleus of complex compds. A (3) 63.
Schwarz, R. and Haack, A. Binary systems of lithium orthosilicate with zirconium and with calcium orthosilicate, A (3) 61.
Scohy, J. R. Sheet glass-drawing app. and method for drawing glass, P (12) 332; Glass cutter, P (8) 217.
Scott, A. Molding sands: their origin and uses, A (5) 136; Recent advances in science: mineralogy and crystallography, A (6) 160; Recent advances in science: mineralogy, A (12) 311.
Scott, V. Note on pipettes, A (12) 306.
Scott, W. S. Indus. elec. htg., A (12) 305.
Seaton, M. Y. Testing of plastic calcined magnesite for use in oxychloride cements, A (3) 88; Plastic calcined magnesite and oxychloride cements, A (7) 192.
Seaton, M. Y., Hill, C. R. and Stewart, L. C. Action of lime in magnesium oxychloride cements, A (7) 193.
Sebring, C. L. Drying rack for pottery manuf., P (8) 199.
Seibert, H. New elec. muffle oven for temps. up to 1350°, A (2) 41.
Seidle, C. B. Plastic bldg. construction, P (11) 297.
Seigel, J. Comparative calcn. on subject of producer gas in case steam is added to blow air, A (5) 141.
Seigle. Operation of elec. blast fur., A (10) 252.
Selch, E. and Garstenauer, R. Regarding accuracy of quantitative chem. analyses, A (8) 201.
Seldon, H. W. Ht. transfer in tanks, A (3) 73; Cleaning producer gas made from bituminous coal, A (6) 127.
Seto, K. Chem. compn. of alkalic feldspar, A (11) 272.
Sexton, A. H. Fuels and refrac. mat., B (12) 316.
Sexton, F. P. Future of indus. research, A (11) 269.
Seydel, R. What happens during firing, A (4) 105.
Shackleton, W. Effects of treating glass surfaces with certain lubricants, A (3) 76.
Shannon, E. V. and Wherry, E. T. Notes on white chlorites, A (10) 250.
Sharkey, S. M. Clays of Mercer County, A (12) 309.
Sharp, D. E. Amer. made 40-in. telescope disc, A (11) 287.
Sharp, H. M. App. for analyzing flue gases, P (4) 115.
Shelley, H. T. and Emley, W. E. Rept. of Comm. C-3 on brick, A (3) 86.
Sherman, P. Frost and obscuring condensation preventative for glass surfaces and method of prepg. same, P (7) 188.
Shertzer, T. B. Advantages of hydrated lime in paving concrete, A (8) 220.
Shibata, R. Note on optical glass, A (11) 289.
Shimmin, J. T. See Knight, F. P.
Shimose, T. Black tile, P (1) 17.
Shipman, C. M. Rendering fur. walls impervious to gases, P (7) 183.
Shively, R. R. Lime specif. for glass manuf., A (12) 331.
Shoeld, M. Phos.-rock-calcining proc., P (5) 132; Treating alunite, P (6) 164.
Showers, L. Finishing glass, P (3) 82.
Shrader, J. E. Elec. tests for porosity of elec. porc., A (11) 283.
Shulenberger, F. W. Viscosimeters, A (2) 33; App. for detn. of moist., A (5) 132.
Shull, A. F. Factor of safety in research, A (10) 245.
Shuman, A. Mach. for and method of making corrugated wire-glass, P (5) 148.
Sicard, H. C. Preserving elec. fur. linings, P (10) 255.
Sieurin, E., Carlsson, F. and Kjellgren, B. Load tests on refrac. bodies at high temps., A (11) 277.
Silsbee, F. B. and Honaman, R. K. Properties and prepn. of ceram. insulators for spark plugs. I. Methods of meas. resist. of insulators at high temps., A (1) 8.
Silverman, A. Development of glass indus., A (3) 77.
Simpson, L. G. Lens-grinding mach., P (11) 271.
Sinclair, N. See Mellor, J. W.
Sinnatt, F. S. and Craven, M. B. Detn. of calorific value of coal, A (12) 311.
Skerrett, R. G. Modern development in manuf. of bldg. glass, A (3) 80.
Slade, W. W. Lens-cutting mach., P (1) 21.
Slawson, C. B. App. for handling deliquescent crys., A (11) 270.
Slocombe, F. E. Grinding or polishing glass and app. therefor, P (7) 190; App. for grinding and polishing plate-glass, P (1) 24.
Smart, B. J. and Pecover, P. C. Anal. of fibrocement, A (2) 51.
Smith, A. D. App. for effecting circulation and maintaining clean surfs. in stills, P (5) 133.
Smith, E. W. Indus. gas and indus. fur., A (5) 140; Symposium on gas firing, A (12) 300.
Smith, E. W., Dunnachie, J., Wilson, S. T. and Thomas, C. W. Symposium on gas firing, A (1) 10.
Smith, H. F. Supplying steam to gas producers, P (5) 131.
Smith, H. M. Method of producing and applying enamel coatings to metallic surfaces, P (12) 334.
Smith, J. Plastic compn. for bricks, P (1) 27; Mixts for making bricks, P (7) 184.
Smithells, A. Blue flame produced by common salt on coal fire, A (11) 269.
Soderberg, J. Glass-rolling mech., P (5) 148.
Somieski, K. See Stock, A.
Sortwell, H. H. High fire porc. glazes, A (1) 12; A (8) 211.
Spackman, H. S. Alumina cement, its development, use and manuf., A (12) 337.
Spence, H. S. New source of soapstone in Ont., A (9) 227; Barium in Can., A (11) 273; Strontium in Can., A (11) 273.
Spencer, G. L. Flask calibrating and marking device, A (3) 76.
Spiers, C. H. Elec. fur., P (3) 68.
Spinasse, A. E. App. for drawing glass cylinders, P (1) 25; Bait for glass-drawing mach. and in proc. of drawing glass, P (2) 49.

Splichal, J. Colloidal system of silica-alumina, A (2) 35.
Splittgerber, A. Destruction of cement and of concrete conduits and masonry for sewage canals, reservoirs and similar works, and suitable means of prevention, A (3) 91.
Springer, J. F. Mach.-drawing of glass tubing, A (3) 78; Steam gage glasses, A (7) 187; Automatic vial necking and bottoming machs., A (7) 187; Steam gage tube situation, A (3) 81.
Springer, L. Smoke nuisance in glass melting, A (3) 78.
Srivastava, J. P. Manuf. of glass with indigenous alkali, A (4) 116.
Steger, W. App. for detn. of deformation of refrac. under load, A (8) 207; Transparency of porcelain, A (11) 280; Translucency of porcelain, A (12) 318; Surf. combustion and possibility of its adaptation in ceram. indus., A (12) 303; Sagger bodies and tests of same, A (12) 321.
Steinbrecht, G. Laying of wall tile, A (11) 284.
Stericker, Wm. Reln. of structure to free alkali in sodium silicate solns., A (2) 38.
Stettbacher, A. Theory and practice of stone-wood (magnesia cement or "compn.") floorings, A (8) 218.
Stewart, J. T. See Marston, A.
Stewart, L. C. See Seaton, M. Y.
Stock, A. Boron and silicon chemistry. Exptl. invest. of very volatile mat., A (2) 36.
Stock, A. and Somieski, K. Siliconhydrides X. Nitrogen-contg. compds., A (3) 64.
Stoll, A. "Mazout" (burning oil) as fuel for lime kilns, A (3) 88.
Stone, R. W. Gypsum in 1920, A (2) 38.
Stowell, E. R. Fireproof and insulating cement mixt., P (3) 93; Refrac. and protective coating on fur. linings, P (4) 109; Cement mixt., P (4) 121.
Stradling, R. E. Some causes of cracking and disintegration of Port. cement concrete, A (12) 338; Port. cement, its testing and specif., A (5) 149.
Strafford, W. Smokeless fuel, A (5) 130.
Straight, H. R. Bearing of vitrified shale, P (4) 97; Fur. for brick and tile kilns, P (8) 199.
Straight, M. T. Phonograph needles of shale or clay, P (9) 225.
Strassmann, P. G. Refrac. and their application to gas works and coke ovens, A (6) 163.
Stuart, A. T. and Middleton, G. N. App. for reaction at high temp. under pressure, P (11) 271.
Sturtevant, L. H. Crushing, storing and pulverizing, A (11) 269.
Suchy, G. New method of setting regenerator chambers, A (3) 73.
Sugden, S. Detn. of surf. tension from rise in capillary tubes, A (8) 204.
Sugie, S. On utilization of selenium, A (11) 287.
Sullivan, C. L. and Fletcher, J. D. Paving block, P (12) 325.
Sullivan, E. C. and Taylor, W. C. Glass, P (3) 82; Glass, P (8) 215, P (8) 216.
Surdo, A. L. Synthetic helium and neon, A (1) 19.
Swanson, H. Polish for glass or metals, P (3) 82.
Sweely, B. T. See Bellamy, H. T.
Swientoslawski, W. and Blaszkowskie, H. and Z. Diff. in meas. obtained on adiabatic and ordinary calorimeters, A (5) 132.
Szekely, H. Cement factory in Torda (Siebenburgen, Hungary), A (2) 52.

Tadokoro, Y. Detn. of thermal condy., sp. ht., density and thermal expansion of diff. rocks and refrac. mat., A (8) 208.
Taffin. Meas. of double refraction in tempered glass, A (6) 166; Annealing of glass, A (8) 216; Annealing and mech. properties of glass, A (9) 238.
Taillefer, A. Pat. legislation and chem. indus., A (7) 175.
Takahashi, S. Mach. for mfg. bricks, P (11) 286.
Takizawa, T. and Tsukamoto, J. Thermocouple for high temp. meas., P (1) 5.
Tanton, T. L. Thunder Bay Dist., Can., A (5) 137.
Taylor, A. B. and Irvine, E. On porosity strength and absorbing power of certain calcium sulphate cements, A (4) 118.
Taylor, H. S. and Neville, H. A. Catalysis in interaction of carbon with steam and carbon dioxide, A (5) 136.
Taylor, M. Eleven years of oil burning experience, A (11) 276.
Taylor, W. Method of and appliance for polishing glass and like subs., P (7) 189; App. for sawing glass, P (1) 23.
Taylor, W. C. Glass, P (8) 216, P (10) 260.
Taylor, W. C. See Sullivan, E. C.
Taylor, W. C. and Bailey, A. Graded seal for joining Pyrex to lead glass, A (2) 47, A (7) 187.
Taylor, W. C. and Gage, H. P. Glass, P (9) 237.
Taylor, W. H. Method for producing flat parallel-shaped glass sheets, P (5) 148.
Teichmann, K. On application of generator gas-firing in ceram. indus., A (4) 105.
Tellier, R. G. Filtering and oil-decolorizing earth, P (6) 159.
Terry, T. B. See Williams, H. M.
Thomas, C. W. Symposium on gas firing, A (12) 301.
Thomas, C. W. See Smith, E. W.
Thomas, W. H. Color circles, A (10) 256.
Thompson, J. G. Elec. fur. purification of zirkite, A (3) 67.
Thompson, S. E. and Goldbeck, A. T. Rept. of Comm. C-9 on concrete aggregates, A (3) 88.
Thompson, W. P. Grinding compds., P (5) 143.
Thomson-Houston. Perfection of elec. porc., A (1) 14.
Thornton, E. R. See Clouser, H. E.
Tillotson, E. W., Jr. Manuf. of constructional glass in U. S., A (3) 72; Putting glass indus. on scien. basis, A (4) 115.
Timm, F. C. W. Zinc oxide, P (9) 225.
Tingley, R. H. Alunite deposits in U. S., A (9) 233.
Tomlinson, C. L. Mirrors, P (3) 82.
Torchino, P. Suggestions concerning college ed. of an engineer, A (12) 305.
Tostman, C. Comparison of cold glazes and cold glazed tile with ceram. wall tile, A (8) 211.
Toupet, J. H. Tile for floor structures, P (12) 326.
Touplain, F. See Bordas, F.
Tralls, R. Pottery: artificial stone, P (6) 165.
Traube, I. Theory of flotation, A (5) 137.
Travers. New method for detg. silicic acid, A (5) 135.
Travers, M. W. On quant. study of tech. probs. in glass indus., A (12) 328.
Travis, W. and Watson, T. H. Elec. resist., P (3) 68.
Trillich, H. Color meas., A (10) 256; Standardization of colors, A (12) 322; Color standards, A (12) 322.
Trinks, W. Graphical treatment of stack gas anal. and fuel gas analysis, A (6) 154; Graphical treatment of stack gas and producer gas anal., A (9) 225.
Trood, S. Oven adapted for burning ceram. ware, P (7) 183.
Troutman, F. E. Mech. for shifting plate-glass and grinding tables, P (1) 23.
Trowbridge, E. E. Drain-tile, P (5) 143.
Truesdell, A. E. Lime burning in rotary kiln, A (9) 242.
Trullinger, D. N. and Granger, L. A. App. for forming concrete pipes, P (12) 339.
Tschermak, G. Chem. constitution of zeolites, A (12) 310.
Tsountas, C. Lighting up a modern vertical cement kiln, A (8) 218.
Tsuboi, H. Elec. fur. for zinc purification, P (9) 234.

Tsukamoto, J. See Takizawa, T.
Tufts, J. L. Magnesium oxychloride cement, P (7) 193.
Turner, W. E. S. See Clarke, J. R.
Turner, W. E. S. See Dimbleby, V.
Turner, W. E. S. See English, S.
Turner, W. E. S. See Firth, E. M.
Turner, W. E. S. See Hodkin, F. W.
Tuschoff, E. Stoneware cooking utensils, A (4) 110.
Twyman, F. See Dalladay, A. J.
Tyler, D. Alumina, P (6) 162.
Tyndall, E. P. T. See Gibson, K. S.
Tyrrell, G. W. Recent advances in sci.-geol., A (12) 311.

Uchida, T. Study of opacity agents for enamels, A (11) 294.
Uehling, F. F. Device for selective absorption from gas in transmission lines, P (10) 246.
Umeda, O. Manuf. of hard porcelain for chem. and elec. purposes, P (3) 71.
Underwood, L. M. Kiln and method of operg. same, P (2) 42.
Ungerer, E. Phenomena of layer formation in clay suspensions and application to soil anal. A (7) 175; Stratification of clay suspensions and its use in detn. of size of clay particles, A (9) 226.
Urbasch, S. Volumetric and gravimetric methods for detn. of zinc in practice, A (7) 174; Volumetric and gravimetric detn. of zinc, A (8) 205.
Utzel, T. Acid-proof cements and stone, A (6) 170.

Vail, J. G. Some properties of commercial silicate of soda, A (9) 223.
Vaillant, P. Variations in conductance of solid electrolytes, A (11) 274.
Van Dijk, W. A. Molding earthenware, etc., P (9) 235.
Van Doren, L. Current chem. pats. and pat. probs., A (10) 246.
Van Marle, M. Means for feeding goods into and removing goods from annealing and other fur., P (9) 239.
Van Zandt, P. C. Asano Port. Cement Co. of Jap., A (12) 337.
Varian, J. P. Retorts for zinc ores, A (8) 208.
Venable, F. P. Zirconium and its compds., B (6) 172.
Vennootschap, N. Glass manuf.; crucibles, etc., P (8) 217.
Verdeaux, F. Use of automatic stokers for high-temp. metal-htg. fur., A (5) 141.
Vickers, C. Type of natural draft melting fur. (II), A (7) 181.
Vigreux, H. Glass blowing in scien. and indus. labs., A (2) 49; Glass blowing. Internal welding, A (4) 116.
Villforth, F. J. G. Production of iridescent effects (interference phenomena) for manuf. of imitation mother-of-pearl, A (5) 143.
Vn. Failure of mortared smoke stack, A (5) 128.
Vogt, J. H. L. Phys. chemistry of crystn. and magnetic differentiation of igneous rocks. (III), A (7) 180.
Voltz, T. See Battegay, M.
Vournazos, A. C. New hydraulic magnesium cement, A (6) 169.
Vreeland, G. W. See McGee, F. R.

Wade, H. Cements, P (5) 151.
Wadhams, A. J. See Reese, C. L.
Waguet, P. New incandescent burner for kerosene and heavy hydrocarbons, A (6) 156.
Wainford, R. H. and Darling, C. H. App. for manuf. of pottery ware, P (11) 284.
Walker, G. L. Blowpipe adapted for htg., welding or cutting, P (7) 184.
Wallace, C. W. Bricks; pottery, P (2) 47.
Wallin, E. Cements, P (3) 92.
Warner, A. W. Complete gasification of coal, A (5) 129.
Warner, G. A. Brickmaking, P (12) 325.
Warren, C. H. Cryst. characters of calcium carbide, A (4) 109.
Wartenberg, H. v. and Schulze, H. Vapor press. of some salts, A (6) 160.
Wartenberg, H. v. and Witzel, G. Molec. hts. at very high temps., A (4) 100.
Washburn, E. W. Phys. chemistry and ceram., A (9) 226, A (12) 310.
Washington, H. S. Chemistry of earth's crust, A (4) 102.
Watson, F. R. Sound-proof partitions, A (9) 242.
Watson, T. H. See Travis, W.
Watts, A. S. Factory prepn. and burning of whiteware bodies, A (12) 320; Feldspar, A (3) 65.
Weber, B. F. Bldg. brick, P (12) 325.
Weber, E. Liquid ceram. pastes, P (7) 193.
Weeks, L. System of kilns, P (7) 182.
Weicker, W. See Scheid, J. F.
Weidert, F. Optical glass, A (4) 116; Production and properties of optical glass, A (9) 236.
Weidlein, R. Place of scien. research in programs of trade assoc., A (11) 269.
Weiker, W. Present demands on porc. insulators, A (6) 164.
Weisenberger, J. Initial-puff mech. for glass-blowing machs., P (8) 216.
Weiser, H. B. and Nicholas, H. O. Influence of concn. of colloids on their pptn. by electrolytes, A (9) 231.
Weiss, H. Glass working-glass-metal joints, P (7) 189.
Weiss, J. and Becker, H. Application of coal in burning brick, A (3) 66; Utilization of crude lignite for brick burning, A (6) 165.
Welch, F. C. Process of improving quality of mason's hydrated lime, P (11) 297.
Welch, H. V. Potassium compds. from cement-kiln gases, P (3) 93.
Wells, R. C. Water of Borax Lake, A (5) 135.
West, C. J. and Hull, C. Investment in chem. ed. in U. S., 1920–1921, A (7) 177.
Westinghouse Lamp Co. Glass manuf., P (6) 167.
Westman, A. E. R. New alternating current elec. fur. installation in dept. of electrochemistry (Univ. of Toronto), A (5) 132.
Wheeler, R. V. Routine gas anal. app., A (8) 199.
Wherry, E. E. See Shannon, E. V.
Whipple, R. S. Difficulties encountered in installation of pyrometer system, A (8) 199; Difficulties encountered in maintaining pyrometer installation in works, A (11) 269.
White, H. J. O. Geol. of Isle of Wight, A (5) 134.
White, W. P. Thermel, A (11) 271.
Whitlock, E. H. and Burgoon, C. E. Ht. distribution in burning cement clinker, A (12) 337.
Whitman, W. G. and Keats, J. L. Rates of adsorption and ht. transfer between gases and liquids, A (8) 204.
Whitney, N. C. Automatic tile-cutter, P (7) 185.
Whitson, A. I. Detn. of available lime in quicklime and hydrated lime, A (2) 52; A (4) 119.
Wierzbowski, F. Firebrick trimming or beveling mach., P (1) 18.
Wietzel, R. Stability relationships of oxides of silicon and fused silica, A (8) 215.
Wilcox, F. H. Hot-blast stove rating, A (6) 163.
Wilde, B. Grinding and prepn. of raw mat. in whiteware indus., A (9) 235.
Wilder, F. A. Conclusions in regard to origin of gypsum, A (6) 160; Gypsum, A (3) 91.
Wildman, H. G. Proc. for extraction of alumina and its salts from clay, A (11) 274.
Wilhelm, O. Manuf. of iridescent glass, A (3) 72.
Wilkes, A. L. Automatic temp. control device for elec. fur., P (3) 68.
Wilkinson, A. See Cowell, R. E.
Willard, E. V. Concrete tile failures in alkali soil, A (11) 284.
Willet, A. H. Arch-brick, P (7) 185; Perforated arch and brick therefor, P (5) 142.
Willetts, P. G. Refrac. ht.-insulating mat., P (3) 68.

Williams, A. D. Design of open hearth fur., A (4) 108; Open hearth fur. design, A (9) 232.
Williams, G. M. Durability of cement drain tile and concrete in alkali soils, A (10) 256.
Williams, H. E. Chromite deposits of Bahia, Brazil, A (9) 233.
Williams, H. M. and Terry, T. B. Melting of cast iron in Booth rotating elec. fur., A (10) 253.
Williams, J. P. Bldg. brick, P (1) 18; Observations on burning, A (8) 213.
Williams, M. Y. Oil possibilities of Manitoulin Island, A (5) 137.
Williamson, E. D. Annealing of glass, A (6) 166.
Williamson, E. D. See Adams, L. H.
Wilson, F. E. See Baillie, W. L.
Wilson, M. E. Fluorspar deposits of Madoc Dist., Can., A (5) 137; Talc in Can., A (9) 228.
Wilson, S. T. See Smith, E. W.
Winch, H. J. and Chand-ratreya, V. L. The volumetric detn. of titanium dioxide in bauxite, A (10) 248.
Winkelmann, H. Detn. of carbon-dioxide content of flue gases from firing of steam boilers, A (5) 130; Detn. of carbon-monoxide and carbon-dioxide content of producer gas, A (5) 130.
Winkler, K. Cements, mortars, etc., P (5) 150.
Winne, H. A. Cottrell proc. of elec. pptn., A (4) 97.
Wingvist, N. Rotating kiln for burning cement, P (11) 279.
Witt, J. W. Interpreting the chem. anal. of Port. cement, A (3) 91.
Witte, G. A. Elec. pptn. of cement mill dust, A (8) 196.
Wittemore, A. P. App. for drawing glass, P (11) 292.
Witzel, G. See Wartenberg, H. v.
Wöhler, L. and Balz, O. Detn. of valence scale of iron, cobalt, nickel, copper, manganese, tin and tungsten by means of water vapor equilibrium and dissociation pressure of oxides of these metals, A (4) 103.
Wolcott, E. R. Elec. pptn. of suspended particles from gases, P (11) 272.
Wolf, K. Wall covering or putty contg. magnesium oxychloride, P (11) 297.
Wolff, H. Detn. of surf. of glass powder, A (9) 237.
Woolf, P. J. Combustion of fuel oil; with description of oil-gas fur., A (12) 301.
Wood, G. B. Fine art of lime burning, A (2) 52.
Wood, J. W. See Cobb, J. W.
Wood, L. A. Concentrating ores, P (6) 162.
Woods, L. G. Brick pallet, P (11) 286.
Worthington, C. C. Bldg.-block, P (7) 194.
Wright, F. E. Manuf. of optical glass and optical systems, B (3) 93; Dispersion in optical glasses, (III), A (7) 186.
Wright, J. A. Refrac. brick, P (8) 210.
Wright, J. F. Brockville-Mallorytown Map-area, Ont., A (5) 137.
Wulf, A. Clay or stoneware utensils for poultry farms, A (4) 110.
Wyatt, J. R. Induction fur. having uni-directional circulation, P (11) 279.

Yamamoto, R. See Mimura, S.
Yoshioka, Y. See Fuha, K.
Young, E. T. Htg. blocks for fireless cookers, P (7) 184.
Young, G. J. Belt, gear and chain drives for grinding mills, A (5) 128.
Young, R. B. and McCarthy, T. V. New methods for propg. concrete, A (9) 240.
Yunoki, S. and Nakazawa, Y. Plating on porcelain or glass, P (9) 235.

Zamboni, M. A. Clays of Tandil Mts., Argentine Republic, A (2) 37.
Zellweger, A. Contribution to knowledge of processes which occur during formation of mortars, A (6) 169.
Zieren, V. Contact body with ceram. mat. as carrier, P (4) 104.
Zimmer, G. F. Conveying mach. in chem. indus., A (9) 225.
Zopf, E. Total-radiation pyrometer, A (11) 271.
Zophy, C. Cement-block mach., P (7) 194.
Zsigmondy, R. Some fundamental conceptions of colloidal chemistry. Elec. charge on particles and new conception of "micelle," A (12) 311.
Zweigbergk, N. v. See Hedvall, J. A.
Zwerling, J. J. Insulating metallic layers, P (4) 121.

SUBJECT INDEX TO ABSTRACTS

Abrasive and refrac. articles, P (11) 280.
bauxite, P (6) 164.
carbides, app. for making, P (2) 43.
for grinding and smoothing glass, P (1) 21, P (7) 184.
garnet, sources and uses of, A (3) 65.
made from fired clays, P (5) 143.
mat. in 1920, A (4) 109.
Abrasives, coated, manuf. and use of, A (3) 68.
manuf. of, P (9) 234.
produced in Brit. Columbia, A (10) 255.
Acetic acid, degree of dissociation of, in water and in salt solns., A (10) 249.
Acid paste for glass etching, A (4) 116.
proof cement, A (3) 88.
and stone, A (6) 170.
-proof refrac. compn., P (1) 11.,
resist. of clay ware, porosity and, A (8) 212.
-resisting ceram. lining for chem. plants, A (3) 82.
Adhesive properties of alkali silicates, increasing the, P (4) 105.
Adriatic, bauxite in the East, A (12) 317.
Adsorption, between gases and liquids, rate of, A (8) 204.
electro, as a purely chem. phenomenon, A (8) 203.
of gas by charcoal, silica and other subs., A (4) 102.
of water by alumina, A (10) 250.
processes, theory of, A (8) 205.
Africa, East, manuf. of tiles in, A (12) 324.
South, asbestos fiber varieties of crocidolite, amosite, chrysotile and tremolite in the Union of, A (12) 306.
Port. cement plant at Lourenco Marques, A (10) 260.
Air, app. for drying and medicating, P (9) 226.
liquid, blasting with, A (3) 58.
Alabaster glass, use of fluorine compds. and asbestos as opacifiers in, A (11) 289.
or milk glass, illuminating, A (3) 77.
Algeria, kaolin from Djebel Debar, chem. compn. of, A (11) 272.
Alkali from natural silicates, P (4) 121.
silicate solns., increasing the adhesive properties of, P (4) 105.
silicates, P (1) 3.
Alkalimetric eosin testing of glassware, A (3) 79.
Alumina, adsorption of water by, A (10) 250.
as an opacifier for opal glass, A (11) 288.
b. p. of, A (1) 10.
cement, its development, use and manuf., A (12) 337.
for withstanding the action of sulfates in earth and water, A (12) 336.
effect of, on the annealing temp. of glass, A (1) 20.
films, drawing, P (4) 108.
from clay, P (4) 117.
process for the extn. of, A (11) 274.
fused, as insulating mat. for elec. heaters, P (4) 109.
influence of, on working properties, viscosity, devitrification, and thermal condy. of glass, A (1) 20.
in glasses, effect on thermal expansion of, A (12) 328.
prepn. of, P (6) 162.
of, from feldspar and similar compns., P (6) 162.
refrac. mat., bonded magnesia and, P (7) 183.
mat. of mixt. of zirconia and, P (4) 108.
-silica, colloidal system of, A (2) 35.
vapor press. of, A (1) 9.
Aluminate of copper, a hitherto unknown spinel type of, A (1) 6.
Aluminates, alkali, prepn. of, P (7) 189.
of calcium, cementing qualities of, A (2) 53.
Aluminous fire clays, effect of adding feldspar to, on shrinkage and porosity after being fired at high temps., A (3) 59.
Aluminum hydroxide, centrifugal method for prepg. colloidal, A (10) 251.
hydroxide, dehydration of cryst., and the adsorption of water by the resulting alumina, A (10) 250.
oxide, mol. heat capacity of, A (4) 100.
prepn. from Al-bearing mat., P (4) 105.
oxy salts and aluminum oxide sols, phys. chem. anal., A (6) 161.
production in Spain, A (8) 209.
silicate and Zr silicate with carborundum as refrac. material, P (3) 68.
Alunite, calcining, P (6) 163.
deposits of the United States, A (9) 233.
treating, P (6) 164.
Amber, high-frequency losses in, A (4) 115.
American Society for Testing Mat., B (3) 93.
Ammonia industry in Japan, present condition of, A (11) 268.
Ammonium sulfates, production of, A (12) 307.
Amorphous solids, mol. structure of, A (7) 175.
Amosite asbestos in South Africa, A (12) 306.
Ampholyte, clay as an, A (8) 203.
Analytical chemistry. An improved iron-manganese sepn., A (5) 136.
Annealing glass, app. for, P (3) 82.
of glass, A (4) 115, A (6) 166, A (8) 216.
mech. properties and, A (9) 238.
of glassware; historical, A (3) 76.
temp. of glass, effect of alumina on, A (1) 20.
influence of silica, A (3) 76.
Antimony, native, from Kern County, Calif., A (5) 137.
Apparatus, enameled-lined, A (3) 83.
Appliances, new, in potting, A (1) 12.
Arch-brick, P (7) 185.
Arch-protector for clamp-kilns, P (5) 143.
Ardometer, total radiation pyrometer, A (11) 271.
Argentine Republic, clays of, A (2) 37.
Art, a plea for toleration in, A (1) 16.
in the pottery indus., A (1) 15.
Asbestos as an opacifier for alabaster glass, A (11) 289.
building block contg. Port. cement and, P (11) 297.
cement building mat., P (4) 122.
-cement mixts., anal. of, A (2) 51.
glass contg. mica or, P (7) 188.
in Rhodesia, production of, A (12) 307.
in the Union of South Africa, fiber varieties of crocidolite, amosite, chrysotile and tremolite, A (12) 306.
use of in glass compns., P (5) 146.
Asphalt concrete paving blocks, A (2) 51.
Asphaltites, vanadiferous, of Central Peru, A (9) 233.
Atkins centrifugal filter press, A (1) 5.
Atomic wts., detns. published in 1921, A (7) 177.
Atoms in crystals, size of, A (9) 231.
Australia, magnesite in W., A (3) 62.
Australian pottery, examples of W., A (12) 319.
Automatic recording and analytical app., A (5) 132.
Avrutik continuous and automatic shifting process for sepg. liquids and solids, A (1) 4.

Babylonian glass slab and vase, chem. anal. of, A (6) 155.
Bait for glass-drawing mach., P (2) 49.
Barium fluoride used to prevent scumming, A (8) 212.
oxide-soda-silica glasses, compn., d., refractive index, dispersion and soly. of, A (4) 112.
oxides, htg. curve study of rapid low-temp. reactions of, A (4) 101.
Baryte mining in Can., general facts concerning, A (11) 273.
Basalt, crushing and screening of, A (8) 196.
Basic refrac. compn., of magnesium limestone, P (4) 108.
mat., P (1) 11.

$BaSiO_3$, m. p., sp. gr., and refractive indices of, A (3) 62.
Ba_2SiO_4, m. p. of, A (3) 63.
Batch, glass, calcns. involving anal. and, A (3) 73.
Bauxite, abrasive, P (6) 164.
brick, cross-breaking strength of, A (3) 67.
cement, fused quick hardening, A (4) 119.
deposits in Spain, A (8) 209.
deposits of the Vogelsberges, A (5) 138.
fused, expansion curves for, between 0° and 1600°C, A (6) 163.
Indian, A (3) 61.
in Dutch East Indies, A (9) 229.
in India, deposits of, A (12) 317.
in Italy, deposits of, A (9) 229.
in Jugoslavia, A (10) 248.
in the East Adriatic, A (12) 317.
of central Georgia, A (2) 37.
purifying, P (5) 139.
volumetric detn. of titanium dioxide in, A (10) 248.
Beads, pearl, a new method of coating, A (3) 72.
Bearings of vitrified shale, P (4) 97.
Belgium, kaolin in, A (1) 8.
Bentonite, description and uses of, A (6) 156.
indus. uses of, A (3) 87.
its products and uses, A (5) 134.
occurrence and uses of, A (9) 222.
Bergman gas and air valve, A (3) 80.
Beryl, use of in spark plug compns., A (1) 9.
$BeSiO_3$, m. p. of, A (3) 62.
Bingham plastometer, variable press., A (1) 6.
Black tile, P (1) 17.
Blast-fur. slags, hydraulic setting properties of basic, A (12) 338.
Blasting with liquid air, A (3) 58.
Blow-holes in earthenware glazes, A (1) 12.
Blowpipe adapted for htg., welding or cutting, P (7) 184.
Block, building, P (4) 122, P (7) 185, P (7) 194.
contg. yellow or white blast fur. slag, P (11) 297.
hollow building, P (1) 18.
paving, P (12) 325.
tank, specif. for, A (12) 330.
Blocks, building, app. for manuf. of, P (1) 18.
compn. contg. asbestos, portland cement, etc., P (11) 297.
made from boiler scale, A (3) 85.
means for, P (8) 215.
plastic, P (11) 297.
Blocks, concrete building, manuf. and use of, A (5) 148.
glass tank, manuf. of, A (3) 79.
htg., for fireless cookers, P (7) 184.
paving, cement and asphalt concrete, A (2) 51.
unburned fire-proof, A (3) 66.
Boiler applicable for use as absorber in absorption refrigerating mach., P (5) 133.
heat losses, A (12) 304.
plant efficiency, A (5) 129.
waste heat, in steel plant, A (12) 304.
Boilers, coal fired and oil fired, A (12) 304.
Boiling pts. of minerals, calcn. of, A (2) 37.
of SiO_2, Al_2O_3, CaO and MgO, A (1) 10.
Bone ash as an opacifier for opal glass, A (11) 288.
Booth rotating elec. fur., melting cast iron in, A (10) 253.
Boron chemistry, A (2) 36.
oxy-compd. associated with iron and chromium as a covering for refrac. articles, P (12) 316.
Boss system of burning and drying, A (11) 267.
Bottle, flint glass, use of light soda ash in, A (3) 79.
Bottles, cause of loss during pasteurization and sterilization, A (3) 73.
comparative strength of prescription, A (3) 75.
glass, app. for making, P (1) 23.
Borax Lake, water of, A (5) 135.
Brazil, chromite deposits of Bahia, A (9) 233.
Brick and tile material in the Isle of Wight, A (5) 134.
application of coal in burning, A (3) 66.
arch-, P (7) 185.
artificial drying of, A (2) 46.
building, P (12) 325.
buildings, Schinkel's Berlin, A (8) 213.
burning, app. for, P (7) 182, P (7) 183.
utilization of crude lignite for, A (6) 165.
cement, included in Report of Comm. C-3, A. S. T. M. on brick, A (3) 86.
chainless carrier for, A (4) 117.
chromite and serpentine refrac., P (8) 210.
clay fire-, softening pt. of mixts. of silica brick and, A (2) 38.
clay sewer, tent. specif. for Comm. C-3, A. S. T. M., A (3) 86.
cleaning mach., P (5) 144, P (12) 327.
concrete, app. for making, P (12) 339.
construction, P (5) 143.
conveyors, A (4) 117.
cross-breaking strength of, chrome, bauxite, magnesia, fire-clay, silica and carborundum brick, A (3) 67.
crushing strength of whole and perforated, A (4) 117.
discoloration of, causes of, A (12) 325.
dolomite, method of mfg., P (3) 67.
econ. use of fuel in firing, in the Hoffmann continuous kiln, A (12) 324.
fireclay, behavior of, in coal gas, A (2) 39.
tent. method of testing resist. to spalling of, A (3) 66.
fire, trimming or beveling mach., P (1) 18.
for wall construction, P (7) 185.
furs. or kilns, P (6) 164.
gas-clinker, manuf. of, at Wurzburg, A (2) 46.
glazes from bog iron ore for, A (4) 117.
-hacking machine, P (11) 271.
method and means for, P (12) 326.
handling, revolving crane for, P (1) 18.
hollow, P (1) 18.
app. for manuf. of, P (8) 215.
building, P (1) 18.
mach. for making, P (1) 17.
industry in New Brunswick, Can., A (12) 323.
interlocking, P (12) 326.
-kiln construction, P (1) 17.
light, manufactured with coal cinders, P (11) 286.
light plaster, A (4) 118.
lime-silica, contg. clay, A (9) 236.
Egyptian, A (5) 149.
mach. for mfg., P (11) 286.
making in remote mining districts, A (8) 201.
fluting app. for, P (12) 325.
manganese for improving color of, A (10) 258.
manuf., app. for, P (1) 18.
improved methods of, A (4) 117.
of, P (2) 47, P (5) 143.
method of manuf. of, P (5) 147.
mfg. cost of, A (4) 117.
mixt. for making, P (7) 184.
mold, multiple, P (7) 193.
pallet, P (11) 286.
pavements, asphalt filler for, A (8) 212.
paving, P (5) 144.
elimination of waste, by standardization of sizes, A (12) 322.
variety simplified, A (8) 212.
perforated arch, P (5) 142.
plant, equipment and opern. of Brooklyn Crozite, A (2) 47.
plastic (cement) compn. for, P (1) 27.
process and mach. for making, P (12) 327.
of mfg. and handling, P (1) 18.
refrac., P (8) 210.
basic, P (5) 142, P (7) 182.
expansion curves for, between 0° and 1600° C., of fused bauxite, clay, silica, chromite, and magnesia, A (6) 163.
for blast furs., A (3) 66.
load tests at high temps. of fire clay, silica and carborundum, A (11) 277.
the after-contraction test on fire and silica, A (11) 278.
Report of Comm. C-3, A. S. T. M. on, A (3) 86

sand-lime, and mortar, properties of, A (9) 242.
and the lime industry, A (4) 118.
hot method of prepg. bodies of, A (4) 118.
increase in strength of, A (2) 45.
steam meters for works of, A (4) 118.
the Neuss works of, A (4) 118.
-scoring mechanism, P (12) 326.
scumming, efflorescence and whitewash on, A (8) 213.
shape, P (12) 327.
silica. See Silica brick.
slag, P (3) 87.
building, manuf. of, A (2) 46.
mach., P (12) 326.
terra cotta, causes of disintegration in, A (3) 85.
testing, Brinnel Ball Method of Le Chatelier and Bogitch for, A (7) 179.
truck for loading and unloading, A (8) 214.
twin wall, P (8) 215.
Brinnel ball method of Le Chatelier and Bogitch, for testing brick, A (7) 179.
hardness testing machines for metals, A (1) 4.
Briquettes, processes for the manuf. of, P (8) 215.
Britain, Great, basic slag manuf. in, A (12) 312.
British ceram. industry, condition and prospects of, A (4) 97.
Brown cold junction compensated pyrometer, A (7) 178.
Brownian movement, theory of, A (12) 311.
B. t. u. calculator, new graphic, A (8) 201.
indicator tests Brady, A (8) 201.
Building blocks See blocks, building.
material, contg. wood fiber, A (9) 236.
exptl. cottages, A (9) 223.
industry in Czechoslovakia, A (9) 223.
Jahr- und Adressbuch der Bau- und keramischen industrie, B (10) 246.
tile, hollow, report of Comm. C-10, A. S. T. M. on, A (3) 87.
tent. specif. for, A. S. T. M., A (3) 87.
Bureau of Mines and private invest., A (5) 128.
Burner, incandescent, for kerosene and heavy hydrocarbons, A (6) 156.
Burning, boss system of drying and, A (11) 267.
brick, app. for, P (7) 182, P (7) 183.
observations on, A (8) 213.
Business situation and outlook, A (12) 300.

Cadmium red, coloring properties of selenium red and, A (11) 286.
Calcium aluminates, cementing qualities of, A (2) 53.
carbide, the cryst. characters of, A (4) 109.
cyanamide, the cryst. characters of, A (4) 109.
oxide, extn. of, from calcined magnesite, A (3) 66.
in stoneware, effect on firing of, A (3) 69.
mol. heat capacity of, A (4) 100.
-soda-silica glasses, compn., d., refractive index, dispersion and soly. of, A (4) 112.
oxychloride, lime and plaster of Paris, as a plastic compn., P (8) 220.
silicide—a new deoxidizing agent, A (2) 36.
Calibrating and marking device, for flasks, A (3) 76.
California, cristobalite in, new occurrence of, A (9) 230.
native antimony from Kern County, A (5) 137.
silica sand operns., A (9) 234.
Calite, a new heat resisting alloy, A (8) 198.
Calorific value of coal, detn. of, A (12) 311.
Calorimeters, differences in the meas. obtained on adiabatic and ordinary, A (5) 132.
gas, P (6) 159.
recording, A (5) 132.
Calorimetry, new graphic B. t. u. calculator, A (8) 201.
$CaMg(SiO_3)_2$, m. p., sp. gr., and refractive indices of, A (3) 63.
Canada, baryte mining in, A (11) 273.
brick indus. in New Brunswick, A (12) 323.
cobalt oxide in, A (9) 229.
deposits of talc in, A (9) 228.
feldspar deposits of the Ottawa District, A (11) 273.
feldspar quarries, A (11) 282.
fire brick manuf. in, A (12) 315.
graphite developments in Buckingham dist., A (5) 134.
graphite, production of, A (12) 314.
pottery clays in, A (11) 273.
strontium in, A (11) 273.
Canadian ceram. specialists for Can., A (9) 222.
china clay mine, A (11) 282.
glass industry, A (3) 71.
institute of chemistry, A (11) 267.
$CaSiO_3$, heat liberated by the formation of, A (5) 144.
m. p. and refractive indices of, A (3) 62.
Ca_2SiO_4–Li_4SiO_4, the system, A (1) 6, A (3) 61.
Ca_2SiO_4, m. p., sp. gr., and refractive indices of, A (3) 62.
Capillary tubes, plastic flow through, A (3) 64.
Carbides, app. for making (abrasive), P (2) 43.
metallic made from fusing W, Mo with diamond dust, P (10) 255.
Carbon arc electrodes, P (6) 159.
brick, load tests at high temps. on, A (8) 208.
dioxide, catalysis of, with carbon, A (5) 136.
indicator of simple design and rugged construction, A (2) 34.
in flue gas when burning oil, interpreting content of, A (11) 267.
in flue gases, automatic and continuous app. for, A (1) 4.
in flue gases, from steam boilers, detn. of, A (5) 130.
in flue gases, practical interpretation of automatically recorded volumetric percentages of, A (10) 249.
in producer gas, automatic and continuous app. for, A (1) 4.
in producer gas, detn. of, A (5) 130.
recorder, Uehling, A (1) 5.
recording instrument, elec., A (6) 159.
electrodes, manuf. of, P (9) 234.
gasification process, theory of, A (4) 106.
liquefaction of, A (4) 102.
monoxide in producer gas, detn. of, A (5) 130.
pyrometer filaments, current-temp. relation for tungsten and, A (4) 98.
the liquefaction of, A (2) 40.
Carbonate ion in glass, detn. of, A (9) 238.
Carborundum as grog in saggers, A (3) 71.
brick, cross-breaking strength of, A (3) 67.
load tests at high temps. of, A (11) 277.
grinding compd., P (5) 143.
in sagger bodies, A (12) 321.
refractories in heat-treating furs., A (2) 40.
-sodium silicate mixt. as refrac. protective coating on fur. linings, P (4) 109.
with Zr and Al silicates as a refrac. mat., P (3) 68.
Carolina, North, kaolin in, A (4) 102.
Casting plate-glass, app. for and method of, P (5) 147.
Catalysis, hydrogen-ion, introduction of a catalysis coeff. in, A (10) 250.
in the interaction of carbon with steam and with carbon dioxide, A (5) 136.
Catalytic action of oxides on decompn. of barium oxides, A (4) 101.
$CdSiO_3$, m. p., sp. gr., and refractive indices of A (3) 63.
Cd_2SiO_4, m. p., and refractive indices of, A (3) 63.
Cement, P (3) 92.
action of sulphur on, A (4) 119.
addition of trass to, A (2) 50.
alumina, its development, use and manuf., A (12) 337.
and cement mortars, vol. alteration of, on setting, A (2) 52.
and silicon-carbide mixts., for non-slip surfaces, A (11) 295.

and soot mixt. for blackboard purposes, A (12) 335.
artificial, by the "two fire" practice, A (3) 88.
asbestos, building mat., P (4) 122.
mixts., anal. of, A (2) 51.
blast-fur., comparison with Port. cement, A (7) 192.
-fur. slag, A (2) 50.
-block mach., P (7) 194.
brick, Report of Comm. C-3, A. S. T. M. on brick, A (3) 86.
brine resisting, P (4) 122.
briquettes, influence of drying on the resist. of, A (5) 148.
burning, heat distribution on clinker, A (12) 337.
heat efficiency increases in, A (5) 150.
in two stages, A (12) 335.
celluloid for, P (3) 92.
chem. compn. of, A (6) 170.
clinker and by-products, P (4) 122.
cold glaze for, P (6) 172.
for building materials and, P (7) 194.
compn., P (6) 171, P (7) 193.
conduits for sewage canals, prevention of destruction in, A (3) 91.
contg. diatomaceous earth, clay, etc., P (12) 316.
dental, P (8) 220.
drain tile, durability of concrete and, in alkali soils, A (10) 256.
effect of temp. on the properties of, A (2) 52.
elec. fused, A (12) 336.
factory in Torda, Hungary, A (2) 52.
works management in, A (4) 118.
floors, insert for, P (12) 339.
fused quick hardening bauxite, A (4) 119.
fusion process for producing, A (12) 337.
hardening of, law governing, A (1) 26.
high alumina, for withstanding the action of sulfates in earth and water, properties of, A (12) 336.
hydraulic, from natural silicates, P (4) 121.
industry, electrified, A (1) 26.
in Punjab, India, A (9) 239.
statistics, for U. S. and foreign countries, A (3) 91.
in 1919, A (3) 91.
kiln for burning, P (6) 172.
gases, potassium compds. from, P (3) 93.
lighting up a modern vertical, A (8) 218.
plant, and method of operg. same, P (5) 150.
kilns, excess air in, A (12) 337.
potash recovery from, A (7) 192.
magnesia, and compds., phys. properties of, A (1) 26.
flooring, theory and practice of, A (8) 218.
magnesium, hydraulic, A (6) 169.
oxychloride, P (7) 193.
oxychloride, action of lime in, A (7) 193.
manuf., recovering potassium compds. in, P (4) 122.
method of mixing and water addition on vol. changes in, A (2) 52.
mill dust, elec. pptn. of, A (8) 196.
mixt., P (4) 121.
fireproof and insulating, P (3) 93.
mortars in sulfate-bearing waters, behavior of, A (2) 50.
relation between tensile and compressive strengths of, A (2) 51.
relation of length of iron reinforcement and the setting of, A (2) 52.
oxychloride, manuf. of, P (3) 92.
paving blocks, A (2) 51.
pipes, impermeable, A (4) 118.
plant, waste heat installation at, A (4) 120.
plastic coating material contg., P (4) 122.
compn. for bricks, P (1) 27.
Portland. See Portland cement.
protection of, against the action of sulphate by means of barium carbonate, A (6) 170.
pyrites ash, P (4) 121.
rotary kiln for burning, P (11) 279.
setting, automatic mach. tests, A (2) 51.
time of, relation of carbon dioxide and moisture to, A (2) 50.
slag, use in construction work, A (12) 338.
slow setting, P (6) 172.
slurry, sintering, rotary kiln for, P (4) 120.
spreading mach., P (12) 339.
standards, English, A (3) 88.
surfaces, coloring, P (4) 121.
tile-making mach., P (12) 339.
waterproofing, P (3) 93.
compn. for, P (5) 150.
compn., of hydraulic cement, lime, etc., P (11) 297.
Cementing qualities of the calcium aluminates, A (2) 53.
compn. for steam pipe joints, P (8) 220.
Cements, acid proof, A (3) 88, A (6) 170.
anal. of gypsum in, by a quick method, A (10), 260.
calcium sulphate, effect of some phys. conditions on, A (3) 90.
compression test mach. for, A (7) 191.
contg. leucite, P (5) 151.
ferriferous, application of, in presence of pozzuolanous subs., A (1) 25.
hardening of, crystallization and transposition phenomena in, A (8) 219.
magnesite oxychloride, A (7) 192.
magnesium, for floor coverings, P (3) 92.
of lime-silica-iron oxide, A (12) 338.
oxychloride, testing of plastic calcined magnesite for, A (3) 88.
plaster, the porosity, strength and absorbing power of, A (4) 118.
purifying molten slag for manuf. of, P (4) 121.
raw mats. of, A (8) 217.
refrac., and protective coatings, A (11) 276.
rendered waterproof, adhesive and quick-setting, P (5) 150.
sea water resisting, P (5) 151.
silicate, P (4) 121.
superior, A (3) 88.
Centrifugal decantation, A (7) 176.
separator, P (6) 159.
Ceramic industries, glimpses of Ohio, A (1) 3.
industry. Jahr- und Adressbuch der Bau- und keramischen industrie, B (10) 246.
industry. Taschenbuch für Keramiker, B (10) 246.
plants visited in France and Belgium, A (11) 267.
station at Rutgers College, State University of New Jersey, new, A (12) 302.
vessel, P (7) 177.
Ceramics and phys. chem., A (9) 226, A (12) 310.
as a by-product of coal-mining in Sweden, A (3) 58.
Ceramite, manuf. of, A (8) 215.
Ceratherm, an acid-resisting ceram. lining for chem. plants, A (3) 82, A (4) 117.
Cerium oxide in glass, having high ultra-violet absorption, P (10) 260.
Chalcedony, a microcryst. form of quartz, A (8) 215.
heat of crystallization of, A (8) 215.
Chapman-Stein recuperator fur. for revolving pots, A (3) 75.
recuperator for pot furs., A (10) 259.
Charcoal, gas adsorption by, A (4) 102.
Checker work on movable carriages for regenerative chambers, A (3) 73.
on movable carriages for regenerative chambers, A (3) 74.
Chemical anal., detn. of sulfate-, chloride- and carbonate ions in soda-lime-silica glass, A (9) 238.
modified method for detecting tin, A (12) 310.
of limestone, lime and hydrated lime, tent. methods of, A. S. T. M., A (3) 90.
of Port. cement, interpreting the, A (3) 91.
regarding the accuracy of quant., A (8) 201.
sepn. of ferric iron and aluminum from calcium by the nitrate method, A (9) 230.

titration of zinc, A (12) 310.
Chemical app., standardization of, A (2) 49.
education in the U. S., 1920–1921, investment in, A (7) 177.
glassware, an autoclave test for the grading of, A (10) 260.
index, international, and the reproduction of documents, A (8) 197.
reactions on surfaces, A (12) 310.
Chemist, the plant manager and the, A (11) 268.
Chemistry, Can. Inst. of, A (11) 267.
of the earth's crust, A (4) 102.
Chloride-ion in glass, detn. of, A (9) 238.
Chlorites, chem. anal. of white, A (10) 250.
Chromatics and its application to painting porcelain, A (11) 280.
Chrome alloys, for app. for handling molten glass, P (8) 217.
brick, cross-breaking strength of, A (3) 67.
Chromite and serpentine refrac. brick, P (8) 210.
deposits of Bahia, Brazil, A (9) 233.
expansion curves for, between 0° and 1600°C, A (6) 163.
in N. Macedonia, A (5) 138.
in 1921, A (10) 254.
Chromium, thermal expansion of, and nickel-chromium alloys over an extended range of temps., A (8) 197.
Chrysotile asbestos in S. Africa, A (12) 306.
Circulation, app. for effecting, in stills, P (5) 133.
Clay, alumina from, P (4) 117.
and clay products industry of Can., A (9) 222.
as an ampholyte, A (8) 203.
brick, load tests at high temps. on, A (8) 208.
making of, A (9) 236.
characterization of, as distinct from silt, etc., A (8) 198.
china, working with mach., A (12) 308.
colloidal, as an ingredient of soap, A (12) 303.
character of, from the practical point of view, A (5) 138.
production, A (10) 247.
uses for, A (11) 282.
content, relation between, and certain phys. properties of soils, A (6) 171.
decompn. of, P (2) 38.
drying, in heated revolving drums, A (3) 85.
expansion curves for, between 0° and 1600°C, A (6) 163.
filter cakes subjected to press. in vacuo, P (12) 322.
images, process of molding, P (11) 284.
in India, china and fire, A (12) 308.
in New Zealand, A (9) 228.
mine, Canadian china, A (11) 282.
new uses for, A (11) 266.
or stoneware utensils for poultry farms, A (4) 110.
"Osmo" Westerwald, A (4) 97.
particles, detn. of size of, A (9) 226.
pipe jointing of a bituminous compd., A (10) 258.
plants, monorail conveyors on, A (8) 196.
potter's, made from kaolinized feldspar, P (10) 256.
prepn. and purification by use of, A (9) 234.
process for the extn. of alumina and its salts from, A (11) 274.
process for treating, P (1) 3.
Products Cyclopedia, 1922, B (10) 262.
products, stand. and tent. methods of sampling and testing highway materials, A (4) 117.
suspensions, phenomena of layer formation in, and their application to soil anal., A (7) 175.
stability of, influence of small amounts of electrolytes on, A (11) 266.
stratification of, A (9) 226.
testing for whiteness of, A (8) 210.
treating, with alk. resinates, P (10) 251.
wad, proper use of, A (1) 12.
ware, resist. to acids of, A (8) 212.
weatherproofing, by pptg. calcium silicate, P (12) 305.
Clays, alumina content of, relation between fusibility and, A (9) 232.
as dispersed systems, A (11) 275.
colloid conc. in, detd. by Tyndallmeter, A (3) 60.
colloidal plasticity of, A (11) 285.
properties of Pleistocene, and their bearing on the chem. theory of the formation of, A (10) 249.
compn., microstructure and fusibility of, A (9) 232.
dehydration of dried, A (11) 285.
drying of china and other, P (12) 322.
fired, abrasive made from, P (5) 143.
for tiles, A (4) 117.
fusibility of, relation between alumina content and, A (9) 232.
Gee-system for filtering, A (6) 154.
mining and purifying, P (4) 97.
of Mercer County, N. J., A (12) 309.
of N. Ontario, A (5) 137.
Clays of Tandil Mts., Argentine Republic, A (2), 37.
of the Mount Hongo, Fukushima prefecture, Japan, used in porcelain making, chem. compn. of, A (11) 272.
of the Saga prefecture, Japan, used in porcelain making, chem. compn. of, A (11) 273.
plasticity of, A (2) 36, A (11) 284.
pot, comparison between siliceous and aluminous, A (12) 330.
pottery, and kaolins in the U. S., A (4) 109.
in Can., location of, A (11) 273.
purification of, by means of electrolytes, A (11) 266.
purified by osmosis, A (3) 58.
rational anal. of, as a plant control, A (8) 214.
rational analyses of, A (11) 272.
refrac., action of heat on, A (11) 272.
treated by electrosmosis, A (2) 36.
white, of central Georgia, A (2) 37.
Clayworking mach., P (5) 131.
Clinker, aging of ground, A (8) 218.
brick, manuf. of gas-, A (2) 46.
Coagulation, discussion on, A (8) 196.
meas. with suspensions, kinetic and static, A (6) 155.
Coal, application of, in burning brick, A (3) 66.
bituminous, cleaning producer gas made from, A (6) 157.
brown, firing with, A (4) 107.
burning vs. oil burning for drain tile, A (11) 276.
calorific value of, detn. of, A (12) 311.
combustion of, in hand-fired furs., importance of air supply in, A (3) 66.
-dust, firing with, a soln. of the coal problem, A (4) 108.
fire, the blue flame produced by common salt on a, A (11) 269.
fired and gas fired boilers, A (12) 304.
firing versus gas firing in kilns, A (12) 300.
gas, behavior of Seger cones and fire-clay brick in, A (1) 9.
gasification of, A (5) 129.
lean, tested in gas producer, A (6) 157.
low-ash, undesirability of a, A (12) 304.
powd., application to air fur., A (6) 154.
powd., prepg. and distributing, A (8) 198.
prepn., transportation and combustion of, A (5) 129.
pulverized, as fuel, A (6) 156.
first large plant using exclusively, A (8) 198.
use of, A (4) 97.
pulverizing anthracite, A (6) 154.
saving, A (4) 108.
in gas works, A (5) 133.
with high sulphur content, burning lime with, A (4) 118.
Cobalt, method for detection and estn. of, A (7) 175.
oxide in Can., A (9) 229.

in soda-lime-silica glasses, coloration effect of, A (12) 328.
Cochius air bubble method of measuring viscosity, A (4) 99.
Cohesion, empirical formula for, A (4) 101.
Coke-oven plants, modernized, A (6) 154.
ovens, methods of measg. large vols. of gas in, A (2) 34.
silica brick for, A (4) 107.
Coking practice, Amer., A (8) 209.
Colemanite, Callville Wash deposit of, A (5) 134.
College training adapted to the needs of industry, A (11) 268.
Colloid chemistry, discussion of, A (12) 310.
fund. conceptions of; elec. charge on particles, and the conception of micelle, A (12), 311.
phys.-chem. anal. of aluminum oxy salts and aluminum oxide sols, A (6) 161.
Colloid soln., law of distribution of particles in, A (8) 204.
Colloidal character of clay from the practical point of view, A (5) 138.
chemistry in ceramics, progress of, since the end of the world war, A (2) 36.
clay as an ingredient of soap, A (12) 303.
production, A (10) 247.
uses for, A (11) 282.
clays, plasticity of, A (11) 285.
dispersion as a cause of translucency and opacity in glasses, A (11) 289.
materials, centrifugal method for prepg. colloidal ferric hydroxide, aluminum hydroxide and silicic acid, A (10) 251.
mill, Plauson, for indus. chem. work, A (2) 34.
phases of silicic acid gel, A (4) 102.
properties of Pleistocene clays, and their bearing on the chem. theory of the formation of gumbotil, A (10) 249.
selenium, note on, A (5) 134.
silicic acid, invest. of prepn. of, A (8) 203.
solns., surface tension of, A (11) 274.
state and colloidal terminology, A (4) 104.
system of silica-alumina, A (2) 35.
Colloids, coagulation of, by electrolytes, A (5) 136.
in clay, detn. of concn. of, by Tyndallmeter, A (3) 60.
influence of concn. of, on their pptn. by electrolytes, A (9) 231.
Les Colloides, B (2) 32.
physico-chem. anal. of zirconium oxychloride and of zirconium oxide sols, A (4) 104.
stability of, and the soly. of small particles, A (11) 275.
Collophane, a calcium phosphate-carbonate rock, A (10) 256.
Color circles, description of, A (10) 256.
meas., A (10) 256.
of, comparative study of methods used for, A (10) 256.
of, theory and practise in recording and, A (10) 256.
the use of secondary ref. stands in process problems of, A (8) 212, A (9) 235.
stands., A (12) 322.
systems of, A (4) 100.
Colored glass. See Glass, colored.
Colorimetric comparison app., A (6) 159.
Colorimetry, proposed stand. method of, A (8) 211.
Coloring materials, constitution of some ceram., A (11) 284.
Colors, standardization of, A (12) 322.
Columbia, British, abrasives produced in, A (10) 255.
fire brick manufactured at, A (9) 227.
fluorspar in, A (9) 229.
gypsum in, A (9) 239.
Combustion, app. for the control of, exposition organized by the Office Central de Chauffe Rationelle, A (4) 98.
constitution and heat of, of org. compds., A (8) 197.
control of, in furs., A (5) 131.
flameless, app. for htg. by, P (1) 11.
of coal in hand fired fur., importance of air supply in, A (2) 42, A (3) 66.
scien. control of, A (1) 4.
surface, A (5) 140.
Compressibility of lubricating oils at high press., A (2) 31.
Concentrating mill, for lead carbonate ores, Santa Barbara, A (7) 176.
ores, P (6) 162.
Concentrator, Wood-Harry cleaner and ore, A (10) 246.
Concrete aggregates, report of Comm. C-9, A. S. T. M., A (3) 88.
aggregates, tent. specif. for, A. S. T. M., A (3) 89.
blast-fur. slag for, A (6) 170.
blocks, building, manuf. and use of, A (5) 148.
brick, app. for making, P (12) 339.
conduits for sewage canals, prevention of destruction in, A (3) 91.
durability of, in alkali soils, A (10) 256.
immersed in sea water 15 years, tests on mortars and, A (10) 261.
light-wt., made with low d. slag, A (11) 296.
mixing mach., P (12) 339.
mixts., effect of hydrated lime on, A (3) 89.
new methods for proportioning, for strength development, A (9) 240.
paving, advantages of hydrated lime in, A (8) 220.
pipes, app. for forming, P (12) 339.
protection of, against the action of sulphates by means of barium carbonate, A (6) 170.
reinforced, effect of temp. on the properties of, A (2) 52.
roofing tile, means for use in the manuf. of, P (7) 194.
tie making machine, P (7) 194.
tile failures in alkali soil, A (11) 284.
water tightness of structures made of, A (12) 335.
Condenser for shale-oil, P (7) 177.
Conductance, elec. of pure metals, temp. coeffs. of, A (7) 180.
of solid electrolytes, variation in the, A (11) 274.
Conductivity, thermal, of refrac. materials and rocks, A (8) 208.
Consistency of varnish, meas. of, A (1) 6.
Constant temp. baths, A (2) 33.
Contact body with ceram. material as carrier, P (4) 104.
Container, ceram., P (7) 177.
Contraction of ceram. bodies fired to different temps., A (3) 59.
Conveying mach. in the chem. industry, A (9) 225.
Coöperation of the engineer and chemist in the control of plants and processes, A (5) 130.
Copper in pyrite and iron minerals, rapid tests for, A (11) 275.
iodometric method for detn. of, A (8) 205.
oxide for coloring glasses, A (10) 258.
ruby glass for casing, A (4) 111.
volumetric detn. of, new method for, A (8) 203.
Cornu's method of detg. the elastic consts. of glass, A (4) 116.
Corrosion of a producer-gas cooling system, A (7) 176.
Corundum, aluminothermic, as a refrac. material, A (2) 40.
artificial, P (10) 255.
manuf. of, A (3) 69.
industry in the Northern Transvaal, A (9) 234.
in sagger bodies, A (12) 321.
in the N. and E. Transvaal, occurrence of, A (12) 317.
in the Transvaal, A (3) 62.
Cottrell process of elec. dust pptn., A (4) 97, A (6) 161.
Cracking, fire, of terra cotta, A (2) 46.

hydrocarbons, app. for reactions at high temp. under press., as, P (11) 271.
Cristobalite, at. grouping and optical rotation of, A (4) 100.
formed during the htg. of silica mat., A (12) 307.
heat of crystn., m. p. of, A (8) 215.
m. p. of, A (8) 215.
new occurrence of, in Calif., A (9) 230.
Critical temps., simple method for detn. of, and melting points, A (8) 202.
Crocidolite asbestos in South Africa, A (12) 306.
Crucibles, refrac., manuf. of, A (4) 106.
Crushing, storing and pulverizing, mech., A (11) 269.
Cryolite in 1920, A (2) 38.
Crystal arrangement detd. by X-ray methods, A (11) 271.
Crystallography, chem. recent work in, A (6) 160.
Crystals, microscopic arrangement for the examn. of opaque, A (10) 247.
size of atoms in, A (9) 231.
Culinary ware, manuf. of, in Switzerland, A (9) 235.
Cutting glass, instructions for, A (3) 78.
notes on, A (3) 77.
Czecho-Slovakia, building materials industry in, A (9) 223.
Faugeron tunnel kiln in, A (12) 302.

Decantation, centrifugal, A (7) 176.
Decorating pottery, process for, P (11) 283.
Deformation of refractories under load, app. for detn. of, A (8) 207.
Dehydration of cryst. aluminum hydroxide and of the adsorption of water by the resulting alumina, A (10) 250.
of dried clays, A (11) 285.
Deliquescent crystals, app. for handling, A (11) 270.
Density, detn. of, and the methods of expressing it, A (6) 161.
detns. by pycnometer, corrections for, A (11) 270.
of barium oxide-potassium oxide-silica glasses, A (6) 165.
soda and potash-silica glasses, A (6) 166.
soda-silica glasses, A (6) 165.
of glasses, and chem. compn., relation between, A (1) 19.
potash-lead oxide-silica, soda-lead oxide-silica, potash and soda-lead oxide-silica, A (3) 81.
potash-lime-silica, soda-lime-silica, potash-lead oxide-silica, soda-lead oxide-silica, A (1) 20.
RO-soda-silica, with oxides of lead, barium, strontium, zinc, calcium and magnesium as RO, A (4) 112.
soda - lime - silica, soda - magnesia - silica, soda-alumina-silica, A (6) 166.
of refrac. mat. and rocks, A (8) 208.
of soda-alumina-silica glasses, A (1) 21.
Dental cement, P (8) 220.
ceramics—a treatise on the technic of porcelain manipulation, A (2) 31.
Design, pottery, from the manufacturer's point of view, A (1) 17.
Devitrification of glass, A (3) 79.
of glasses, potash-lime-silica, soda-lime-silica, potash-lead oxide-silica, soda-lead oxide-silica, A (1) 20.
of sheet glass, surface, A (11) 290.
Diamond-drill sampling methods, A (5) 136.
Diatomaceous earth in cement and mortar, P (12) 316.
Die for making articles of plastic mat., P (5) 133.
Dielectric anomalies of silica glass, A (10) 257.
high frequency losses in, A (4) 115.
strength of solid insulating materials, as varnished cloth, mica paper, micanite, etc., A (12) 321.
Diffusion in porous vessels, A (6) 161.
in silicate melts, A (1) 8.
Dinas stone, manuf. and use of, A (2) 40.
Dispersion in optical glasses, A (7) 186.
of soda-alumina-silica glasses, A (1) 21.
(total) of barium oxide-potassium oxide-silica glasses, A (6) 165.
of barium oxide-soda and potash-silica glasses, A (6) 165.
of barium oxide-soda-silica glasses, A (6) 165.
of glasses, potash-lead oxide-silica, soda-lead oxide-silica, potash and soda-lead oxide-silica, A (3) 81.
of glasses, potash-lime-silica, soda-lime-silica, potash-lead oxide-silica, soda-lead oxide-silica, A (1) 20.
of glasses, RO-soda-silica, with oxides of lead, barium, strontium, zinc, calcium and magnesium as RO, A (4) 112.
Dissociation press. of the oxides of metals, A (4) 103.
Distribution of particles in colloid soln., law of, A (8) 204.
Dixon muffle leer, A (3) 76.
Doll's heads, coloring, method of, A (5) 142.
Dolomite brick, method of mfg., P (3) 67.
burned, in basic refrac. mat., P (1) 11.
converting, into magnesite, A (5) 134.
for fur. linings, P (4) 109.
in conducting elec. fur. hearth structures, A (4) 107.
sintered, A (3) 66.
tar mixt. in Thomas (basic converter) steel works, prepn. of, A (2) 39.
Dolomites, American chem. compns. of, A (2) 37.
Doolittle torsion viscometer, A (1) 6.
Draft, artificial, in firing, A (4) 106.
device for labs., A (8) 200.
Drain tile, P (5) 143.
report of Comm. C-6, A. S. T. M. on, A (3) 86.
Drier for use in the manuf. of articles from tender clay, P (7) 185.
pottery, of the conveyor type, A (1) 5.
Dry-kiln, P (1) 3.
Drying air, app. for medicating and, P (9) 226.
app., elec., P (7) 179.
artificial, of brick, A (2) 46.
Boss system of burning and, A (11) 267.
bricks, stones and ores, app. for, A (11) 285.
clay in heated revolving drums, A (3) 85.
rack for pottery manuf., P (8) 199.
Durability of optical glass, methods of detg., A (12) 329.
Dutch East Indies, bauxite in, A (9) 229.

Earth, filtering and oil-decolorizing, P (6) 159.
Earthenware bodies, effect of calcination of flints on, A (3) 70.
Earth's crust, chemistry of, A (4) 102.
Economic mineralogy, A (8) 202.
Education of an engineer, some suggestions concerning the, A (12) 304.
Efflorescence on brick, A (8) 213.
Egyptian lime-silica brick, A (5) 149.
Elastic consts. of glass, Cornu's method of detg., A (4) 116.
Electric blast fur., opern. of, A (10) 252.
carrier for filled saggers, A (1) 12.
charge on particles, discussion of, A (12) 311.
drying app., P (7) 179.
enameling oven, A (6) 169.
fur., P (5) 133.
adapted for refining metals, P (11) 279.
arc type, for melting glass, A (3) 66.
Booth, melting cast iron in, A (10) 253.
cast iron as produced in, A (10) 254.
cost of heat-treated parts reduced by, A (10) 252.
crucible, P (9) 234.
equipment in steel plant, A (10) 252.
Fiat, A (10) 252.
for baking vitreous enamel, operg. costs for, A (6) 168.
for carbide manuf., P (8) 210.
forging and heat-treating, A (6) 163.
for temps. up to 1700°, muffle, A (8) 209.
for zinc purification, P (9) 234.
hearth structures, stability of conducting, A (4) 107.

Heroult, A (8) 208.
in melting and refining, A (6) 163.
linings, titanium oxide in, P (10) 255.
melting, A (10) 252, A (10) 253.
melting aluminum in, A (10) 253.
new alternating current, A (5) 132.
operns., intermittent and alternating, A (10) 251.
purification of zirkite, A (3) 67.
radiation glass, A (9) 236.
refrac., cover for, P (8) 201.
regulator systems, P (11) 279.
rotating, P (5) 133.
the elec. fur. in the iron foundry, B (11) 280.
tilting, P (9) 234, P (11) 280.
furnaces, P (3) 68, P (11) 279.
arc, P (9) 234.
automatic temp. control device for P, (3) 68.
electromagnetic motions in, A (10) 254.
for steel, construction of, A (10) 246.
indus., A (12) 305.
in steel making, present status of, A (8) 209.
lab., A (11) 276.
lab. types of, A (2) 41, A (2) 42.
opern. of basic, A (5) 140.
refrac. cover for, P (9) 234.
refractories for, A (4) 107.
temp.-control devices for, P (4) 109.
glass-annealing fur., P (6) 167.
heat for thermal processes, A (7) 178.
heaters, fused alumina as insulating material for, P (4) 109.
htg. device for glass furs., automatic, P (12) 333.
furs. in steel works, A (2) 41.
insulating compns., P (4) 108.
insulators, molded clay, cement, fiber compn., P (8) 220.
lamp bulb glass, P (8) 215.
glass for manuf. of, P (3) 82.
muffle oven for temps. up to 1350°, A (2) 41.
plants, fuel economy in burning coal, oil, gas and hogged fuel in, A (12) 304.
porcelain, elec. tests for porosity of, A (11) 283.
testing of in Germany, A (8) 211.
zircon spark plug, A (12) 321.
power in iron and steel industry, application of, A (9) 233.
resistances, method of protecting, P (3) 68.
steel plant at the S. Pacific shops, A (11) 278.
The Elec. Fur., B (2) 42.
tool steel melting practice, A (10) 252.
Electrical conductance of pure metals, temp. coeffs. of, A (7) 180.
htg. app. for liquid and solid chemicals, A (7) 177.
insulation, black glass for, P (6) 167.
impregnated fabric as, P (11) 269.
insulators, stoneware body for, A (4) 111.
porcelain, discussion of high tension, A (4) 111.
research, A (11) 282.
pptn., A (9) 225.
Cottrell process of, A (4) 97.
of cement mill dust, A (8) 196.
of suspended particles from gases P, (11) 272.
of suspended particles from gases, app. for, P (6) 159.
properties of glass, A (7) 187.
resist. of insulators at high temps., methods of meas., A (1) 8.
tests for porosity of elec. porcelain, A (11) 283.
Electro-adsorption as a purely chem. phenomenon, A (8) 203.
Electrochemical developments, auxiliary, for hydroelec. plants, A (7) 177.
Electrochemistry, geography of; hydro development, A (11) 269.
Electrode furs., having counterbalancing electrodes, P (11) 279.
Electrodes, carbon arc, P (6) 159.
Electrolysis of coal and hydrocarbons, P (6) 162.
Electrolytes, activity coeffs. and colligative properties of, A (7) 175.
clay prepn. and purification by use of, A (9) 234.
coagulation of colloids by, A (5) 136.
degree of dissociation of acetic acid in water and in salt solns., A (10) 249.
for obtaining plasticity of clays, P (5) 131.
influence of small amts. of, on stability of clay suspensions and their use in purification of clay, A (11) 266.
mixt. of, for clay bodies, P (6) 172.
pptn. of colloids influenced by the concn. of, A (9) 231.
solid, variation in the conductance of, A (11) 274.
Electrosmosis, applications to indus. of, A (1) 245.
of clays, A (2) 36.
technical application of, A (8) 198.
Elutriating clays, Gee-system, A (6) 154.
Elutriation test for potters, A (3) 65.
Emery exports, Greek, A (12) 317.
Enamel, P(11) 295.
coatings, method of producing and applying, to metallic surfaces, P (12) 334.
elec. fur. for baking vitreous, operg. costs for, A (6) 168.
ground-coat, effect of variation in the compn. of, on its adherence to iron, A (11) 293.
-lined app., A (3) 83.
spraying process, new Meurer, A (3) 85.
ware, muffle oven for decorating or annealing, P (7) 188.
Enameled equipment, uses for indus., A (5) 148.
metal surfaces, de-enameling by htg., P (12) 335.
Products Research Lab., A (3) 85, A (7) 191.
steel manuf. A (3) 83.
ware, A (5) 134.
Enameling by contact with ignited gas, P (4) 118.
cast-iron and steel mat., A (7) 191.
furs., P (5) 131.
marine blue pigment compns. for, A (11) 294.
oven, elec., A (6) 169.
slip, study of vehicles in, A (11) 293.
Enamels for tinware, A (6) 167.
opacity agents for, as oxides of tin, antimony, zirconium, cerium, lead, zinc and arsenic, and other compds., A (11) 294.
selenium as a constituent of glass and, A (11) 287.
spit-out of glazes on passing through an enamel kiln, A (12) 319.
Engineer, some suggestions concerning the college education of an, A (12) 304.
Engineering education, instructing students in the use of technical lit., A (10) 246.
Eosin reaction for alkalimetric testing of glassware, A (3) 79.
Etching of flashed glasses, A (3) 81.
Expansion, thermal, of refrac. materials and rocks, A (8) 208.

Factory organization, some general remarks for, A (4) 97.
Faience, stanniferous, making of, A (8) 210.
Fairweather recording calorimeter for gas calorific values, A (11) 270.
Faugeron tunnel kiln car, A (3) 70.
in Czecho-Slovakia, description of, A (12) 302.
Feldspar, chem. compn. and optical consts. of alkalic, A (11) 272.
decompn. of, P (2) 38.
deposits of the Ottawa District, Can., A (11) 273.
effect of adding, on shrinkage and porosity of aluminous fire clays after being fired at high temps., A (3) 59.
ferro-silicon bearing potash made from, A (12) 309.
grinding mills of, A (3) 65.
in 1920, A (4) 103.
prepn. of alumina and potassium compns from, P (6) 162.
quarries, Can., A (11) 282.
sol. compds. from, P (4) 104.

Feldspars, potash-soda, sp. gr. and index of refraction relationships for, A (12) 309.
soda-potash, sp. gr. and index of refraction relationships for, A (12) 309.
Ferric hydroxide, centrifugal method for prepg. colloidal, A (10) 251.
Ferromagnesian silicates, soly. of, in acid and basic magmas, A (7) 180.
Ferro-silicon bearing potash made from feldspar, A (12) 309.
Fiat elec. fur., A (10) 252.
Fibro-cement, the anal. of, A (2) 51.
Filling mat. for use in Glover towers, P (6) 160.
Filter press, a new centrifugal, A (1) 5, A (2) 33.
Atkins centrifugal, A (1) 5.
with a rotary filter, P (10) 256.
Filter Presses recessed plate and plate and frame; their construction and use, A (7) 178.
standardization of, A (11) 283.
Filtering app., modern, A (2) 33.
earth, oil-decolorizing, P (6) 159.
Filtration, study of the fund. laws using plant-scale equipment, A (2) 33.
vacuum app., P (6) 160.
Finland, kaolin deposits in, A (12) 309.
Fire brick, manuf. in Can., A (12) 315.
manufactured at Clayburn, British Columbia, A (9) 227.
the after-contraction test of, A (5) 141, A (11) 278.
Fire clay and fire clay grog mortar mixts., A (2) 39.
brick, behavior of, in coal gas, A (2) 39.
cross-breaking strength of, A (3) 67.
in coal gas, behavior of, A (1) 9.
load tests at high temps. of refrac., A (11) 277.
British, shrinkage, porosity and other properties of, after being fired at high temps., A (6) 166.
dark colored pipe from, A (8) 212.
refrac. heat insulating mat., P (3) 68.
Russian, A (9) 223.
Fire clays, aluminous, effect of added feldspar on shrinkage and porosity of, after being fired at high temps., A (3) 59.
of Illinois, classification, properties and uses of, A (12) 316.
Fire cracking of terra cotta, cause of, A (3) 85.
Firing earthenware, through independently controlled zones, P (11) 284.
pottery, prac. economies in, A (4) 106.
technique in the ceram. industry, engineers for, A (4) 97.
temps. attainable with wood, A (4) 108.
what happens during, A (4) 105.
with artificial draft, A (4) 106.
with brown coal, A (4) 107.
with coal dust—a soln. of the coal problem, A (4) 108.
with lignite and briquettes, reconstruction of grates for, A (4) 107.
Flame of exceptionally high temp., researches of, A (2) 41.
Flameless combustion. See Combustion.
Flask calibrating and marking device, A (3) 76.
Flattening ovens, circular, for plate glass, A (4) 111.
Flint, comparison of Amer. and German quartz and, used in the ceram. industries, A (12) 311.
effect of htg. on the properties of, A (12) 307.
Flints, effect of calcination of, on earthenware bodies, A (3) 70.
Flocculation of soils, A (6) 171.
Floor coverings, made with magnesium compds., P (2) 54.
Flooring, magnesia cement, A (1) 26.
magnesia cement, theory and practice of, A (8) 218.
Florida, fullers' earth in, prepn. of, A (5) 128.
Flotation, mineral sepn. by, review of German patents on, A (5) 129.
of sulfide ores in the lab., A (5) 138.
theory of, A (5) 137.
Flue gas testers, description of, A (8) 200.
gases, detn. of carbon dioxide in, from steam boilers, A (5) 130.
system, Minter, for increasing kiln vol., A (10) 257.
Fluidity and Plasticity, B (6) 172.
Fluorescence in glass due to α-rays, A (12) 328.
Fluorescent and phosphorescent compds., prepn. of, A (11) 276.
Fluorine compds. as opacifiers for alabaster glass, A (11) 289.
as opacifiers for opal glass, A (11) 288.
Fluorspar deposits of Madoc District, Ontario, A (5) 137.
in British Columbia, A (9) 229.
in Prussia, Germany, A (12) 307.
in 1920, A (2) 33.
Fluostannite of Mg, Ba or Pb, as opacifier for glass, P (11) 293.
Foundry sand, P (8) 199.
Fuel, econ. use of, in firing brick by the Hoffmann continuous kiln, A (12) 324.
economy. Excess air as a cause of waste, A (6) 155.
for elec. plants burning coal, oil, gas and hogged fuel, A (12) 304.
gas anal., graphical treatment of, A (6) 154.
liquid, burning in jets, P (5) 131.
use of in Hoffmann kilns, A (6) 155.
powd., description of Turbo pulverizer, A (6) 156.
pulverized, burning of in paper mill power plants, A (7) 174.
coal as, A (6) 156.
saving in boiler plants, A (12) 304.
in modern gas producers and indus. furs., A (5) 129.
smokeless, A (5) 130.
for domestic purposes, A (5) 131.
tests, comparison between lab., and working results of producer gas process, A (7) 176.
waste, reduction of, in the steel industries, A (8) 209.
water-gas generator, coal and coke mixts. as, A (6) 156.
Fuels and Refractory Materials, B (12) 316.
gaseous, improvement of fur. using, P (4) 108.
liquid, colloidal and powd., A (4) 97.
pulverization of, A (10) 245.
Fullers' earth deposit at Olmstead, Ill., A (7) 176.
in Florida, prepn. of, A (5) 128.
in New Zealand, A (9) 228.
Japanese, its properties, chem. applications, and relation to the geological formation of petroleum, A (7) 180.
production in 1920 of, A (5) 128.
Furnace, air, application of powd. coal to, A (6) 154.
blast, disintegration of linings of, A (7) 181.
blast, E. Steel Co. new, A (7) 181.
Chapman-Stein, for revolving pots, A (3) 75.
Chapman-Stein recuperative pot, A (10) 259.
elec., P (5) 133.
adapted for refining metals, P (11) 279.
arc, P (9) 234.
blast, opern. of, A (10) 252.
Booth, melting cast iron in, A (10) 253.
cast iron as produced in, A (10) 254.
cost of heat-treated parts reduced by, A (10) 252.
crucible, P (9) 234.
electromagnetic motions in, A (10) 254.
equipment in steel plant, A (10) 252.
Fiat, A (10) 252.
for baking vitreous enamel, operg. costs for, A (6) 168.
for carbide manuf., P (8) 210.
forging and heat-treating, A (6) 163.
for zinc purification, P (9) 234.
glass annealing, P (6) 167.
Heroult, A (8) 208.
in melting and refining, A (6) 163.
intermittent and alternating operns., A (10) 251.
melting, A (10) 252, A (10) 253.
melting aluminum in, A (10) 253.
muffle, for temps. up to 1700°, A (8) 209.
new alternating current, A (5) 132.
radiation glass, A (9) 236.

refrac. cover for, P (8) 201.
regulator system for, P (11) 279.
rotating, P (5) 133.
The elec. fur. in the iron foundry, B (11) 280.
tilting, P (9) 234, P (11) 280.
for brick and tile kilns, P (8) 199.
for deformation temp. of refractories, lab., A (8) 209.
for mfg. tile, P (2) 47.
gas, and method of conveying mat., P (7) 182.
glass-melting, P (5) 147.
glass tank, P (1) 24.
improvement of, using gaseous fuels, P (4) 108.
induction, having uni-directional circulation, P (11) 279.
kiln, P (7) 183.
lining, dolomitic, P (4) 109.
merits of one piece, A (12) 314.
linings, P (3) 68.
Mathews recuperator pot, A (3) 75.
natural draft brass melting, A (7) 181.
open hearth, designs for, A (9) 232.
parts, heat resisting alloy for, P (7) 188.
pot, control of, conditions through pyrometry, A (9) 237.
recuperative glass, A (9) 236.
roofs, baked in position, P (7) 183.
tank, white flint glass made in, A (12) 330.
temp. regulator, A (4) 98.
The Elec. Fur., B (2) 42.
walls, rendered impervious to gases, P (7) 183.
zinc-smelting, P (5) 142.
Furnaces, brick or kilns, P (6) 164.
control of combustion in, A (5) 131.
conveying app. for annealing and other, P (9) 239.
elec., P (3) 68, P (11) 279.
arc type, for melting glass, A (3) 66.
for steel, construction of, A (10) 246.
having counterbalancing electrodes, P (11) 279.
htg., in steel works, A (2) 41.
indus., A (12) 305.
Furnaces, elec., lab. types of, A (2) 41, A (2) 42.
opern. of basic, A (5) 140.
present status of, in steel making, A (8) 209.
refrac. cover for, P (9) 234.
refractories for, A (4) 107.
temp.-control devices for, P (4) 109.
Furnaces for enameling ceram. or other ware, P (5) 131.
heat-treating, carborundum brick in, A (2) 40.
function of insulation and its application to, A (1) 8.
indus. and indus. gas, A (5) 140.
fuel saving in, A (5) 129.
metal-htg., use of automatic stokers for high temp., A (5) 141.
metallurgical, calcn. of working temp. in, A (8) 209.
open hearth, design of, A (4) 108.
steel-works, and gas producers, A (5) 141.
temp. meas. in melting and annealing, in the alloy industry, A (5) 133.
use of fused quartz in, P (4) 108.
Fused quartz as grog in saggers, A (3) 71.
in furnaces, use of, P (4) 108.
Fusion and solidification, influence of surface tension on, A (1) 7.
and transition, reduced temps. of, mathematical anal., A (8) 204.
heats of, of soda-lime-silica glasses, A (5) 144.

Gage glasses, steam, A (7) 187.
Ganister, its production and uses, A (5) 142.
Garnet, abrasive, sources and uses of, A (3) 65.
occurrence and uses, A (10) 255.
Gas adsorption by charcoal, silica and other substances, A (4) 102.
anal. app., P (7) 179.
app., routine, A (8) 199.
Brady B. t. u. indicator tests, A (8) 201.
flue, description of tester for, A (8) 200.
graphical treatment of stack and fuel, A (6) 154, A (9) 225.
modified Orsat app. for flue, A (10) 249.
new graphic B. t. u. calculator, A (8) 201.
calorific value, detd. by means of Union gas calorimeter, A (11) 271.
Fairweather recording calorimeter for, A (11) 270.
calorimeters, P (6) 159.
device for selective absorption in transmission lines, P (10) 246.
fired and coal fired boilers, A (12) 304.
continuous kiln, P (6) 164.
pottery kiln, P (12) 305.
firing, generator, in the ceram. industry, A (4) 105.
short and long flames in, A (3) 66.
symposium on, A (1) 10, A (12) 300.
vs. coal firing in kilns, A (12) 300.
importance of clean, for the producer plant, A (9) 224.
indus., and indus. furs., A (5) 140.
manuf., P (6) 158.
and tar recovery with special attention to carbonization of lignites, A (5) 130.
methods of meas. large vols. of, especially applicable to gas plants and coke ovens, A (2) 34.
plant, Pintsch-generator, and results of opern. with different fuels, A (5) 130.
producer, automatic and continuous app. for carbon dioxide in, A (1) 4.
cleaning, made from bituminous coal, A (6) 157.
cleaning without washing, A (9) 233.
comparative calcns. on the subject of, in case steam is added to the blow air, A (5) 141.
comparison between lab. fuel tests and working results of, A (7) 176.
cooling system, corrosion of, A (7) 176.
plant design for, A (9) 224.
report of expts. in window glass works using, A (11) 267.
some critical observations on the generation of, A (6) 157.
using clean cold, A (6) 158.
producer, P (10) 246.
lean coals tested in, A (6) 157.
process, low-temp., by-product recovery, A (10) 245.
producers, comparison between stationary and mech., A (10) 245.
fuel saving in, A (5) 129.
steel-works furs. and, A (5) 141.
supplying steam to, P (5) 131.
producing system, Moore, A (5) 141.
water-, coal and coke mixts. as fuel for generating, A (6) 156.
continuous producer for, A (6) 157.
theory of the, A (5) 131.
works refractories, chem. and phys. of, A (9) 233.
Gaseous firing for indus. purposes, A (6) 156.
Gases, app. for elec. pptn. of suspended particles, P (6) 159.
automatic anal. of, P (4) 99.
carbon dioxide in flue, practical interpretation of automatically recorded volumetric percentages of, A (10) 249.
chem. constitution and viscosity of, relation between, A (8) 215.
combustion of, some simplified formulas for excess air in the, A (10) 248.
elec. pptn. of suspended particles from, P (11) 272.
flue, app. for analyzing, P (4) 115.
flue, automatic and continuous app. for carbon dioxide in, A (1) 4.
kiln, measuring, A (10) 247.
medium-grade, use of, in the steel industry, A (6) 155.
passage of, through hot glass, A (1) 19.
recording combustible, A (5) 133.
viscosity and chem. constitution of, relation between, A (8) 215.
Gasification process, theory of, A (4) 106.
Gee-system for elutriating clays, A (6) 154.

Gel, silica. See silica gel.
Gelatin, swelling and gelation of, effect of sodium silicate on, A (3) 60.
Geology, recent advances in chemistry of metamorphic rock and in volcanology, A (12) 311.
Georgia, white clays and bauxites of central, A (2) 37.
German Ceram. Soc., third annual meeting of, A (11) 267.
glass society, organizing a, A (11) 267.
sources of silica useful in the glass industry, A (3) 73.
Germany, fluorspar in Prussia, A (12) 307.
Glass. A discussion of the making of reflecting surfaces, B (1) 27.
abrasive for grinding and smoothing, P (1) 21, P (7) 184.
action of iron and other metals upon clay pots and molten, A (9) 237.
alabaster or milk illuminating, A (3) 77.
use of fluorine compds., and asbestos as opacifiers in, A (11) 289.
anal. and batch, calcns. involving, A (3) 73.
ancient, decompn. of windows in the church of Thann, A (12) 332.
annealed, meas. of double refraction of, A (6) 166.
annealing, A (6) 166.
and the mech. properties of, A (9) 238.
app. for, P (3) 82.
fur., elec., P (6) 167.
influence of silica on temp. of, A (3) 76.
of, A (4) 115.
of, laws of, A (8) 216.
app. for the manuf. of, in continuous sheets, P (11) 291.
articles, art of ornamenting, P (5) 147.
combination blank and finishing molds for, P (2) 49.
mach. for manuf. of, P (7) 191.
manuf. of, by mach., P (5) 145.
automobile-headlight, P (1) 21.
batch, gypsum as a substitute for limestone in the, A (3) 78.
melting, vertical conical shaped tank for, P (12) 332.
batches, colored, A (3) 77.
contg. soda-ash and salt-cake, relative merits of limestone, burned lime and slaked lime in, A (12) 328; A (12) 329.
melting of lime in, A (7) 186.
black, P (6) 167.
for elec. insulation, P (6) 167.
blowing in scien. and indus. labs., A (2) 49.
internal welding, A (4) 116.
mach. initial puff mechanism for, P (8) 216.
blown, method and app. for finishing articles of, P (7) 189.
borosilicate, for joining Pyrex to lead glass, A (2) 47.
bottles, causes of loss during pasteurization and sterilization, A (3) 73.
comparative strength of prescription, A (3) 75.
mach. for making, P (1) 23.
manuf. of milk, A (7) 187.
building, modern development in manuf. of, A (3) 80.
building stones, "Keramo," A (3) 81.
Canadian, industry, A (3) 71.
carrier for articles of, P (7) 190.
cleansing and polishing paste, P (3) 82.
color of, imparted by iron oxides, A (11) 289.
colored, contg. manganese dioxide and chromium oxides, P (8) 216.
compn., P (8) 216.
and method of making same, P (5) 146.
Belgian, A (5) 145.
non-electrolytic, composed of silicates and borates of calcium and barium, P (11) 292.
condy. of, effect of absorbed gas on, A (12) 330.
containers, free alkalinity in, A (7) 187.
contg. mica or asbestos, P (7) 188.
titanium oxide in large quantities, P (10) 260.
copper ruby, for casing, A (4) 111.
corrugated, wire, mach. for and method of making, P (5) 148.
covered steel rolls, P (7) 188.
cullet as an aid to melting, A (7) 186.
cutter, P (7) 190, P (8) 217, P (12) 333.
rotary, P (12) 333.
cutting, instructions for, A (3) 78.
mach., P (7) 190.
mechanism, P (7) 188.
notes on, A (3) 77.
square, P (11) 292.
table, P (7) 188.
cylinders, app. for drawing, P (1) 25; P (11) 292.
daylight, P (7) 188.
decoration, A (7) 186.
delivery app., P (5) 146.
devitrification of, A (3) 79.
alumina preventing, A (1) 20.
discharging mechanism, P (5) 146.
drawing and painting, P (1) 21.
app., cooling device for, P (5) 147.
mach., bait for, P (2) 49.
method of and app. for, P (12) 333.
effect of alumina on the annealing temp. of, A (1) 20.
effect of rays from radium, X-rays, and ultraviolet rays on, A (10) 259.
elastic consts. of, Cornu's method of detg., A (4) 116.
elec. properties of, A (2) 48, A (7) 187.
etching, acid paste for, A (4) 116.
feeding molten, app. for, P (7) 189.
process and app. for, P (11) 292.
to molds, app. for, P (11) 293.
flint bottle, use of light soda ash in, A (3) 79.
flow-off controller, P (11) 291.
fluorescence in, due to α-rays, A (12) 328.
for elec. lamp bulbs, P (8) 215.
for lab. and scien. purposes, batches for, A (11) 287.
for manuf. of elec. lamp bulbs, P (3) 82.
for preserve jars, need for improvement in, A (3) 81.
frosted, and process for making same, P (1) 22.
frosting and obscuring condensation preventive, and method of prepg. same, P (7) 188.
fur., recuperative, A (9) 236.
furs., automatic elec. htg. device for, P (12) 333.
furs., elec. heated delivery trough for, P (2) 49.
gage, construction, P (12) 334.
gas absorption in, condy. affected by, A (12) 330.
gathering app. using ladle, P (12) 334.
German society, organizing a, A (11) 267.
graded seal for joining Pyrex to lead, A (2) 47, A (7) 187.
grinding or polishing of, and app. for, P (7) 190.
handling app., P (11) 292.
heat-intercepting, manuf. properties and employment of structural, A (5) 145.
industry, development of, A (3) 77.
elec. load conditions in, A (1) 19.
German sources of silica for, A (3) 73.
putting, on a scien. basis, A (4) 115.
quant. study of technical problems in the, A (12) 328.
some aspects of science applied to, A (9) 236.
influence of alumina on the working properties of, A (1) 20.
iridescent, manuf. of, A (3) 72.
lab., compn., P (7) 188.
lead, graded seal for joining Pyrex glass to, A (7) 187.
leer, a novel, A (6) 167.
lens-cutting mach., P (1) 21.
lens-grinding mach., P (11) 271.
lime-flint, specif. for tumblers made of, A (9) 236.
lime-flint, tumblers, specif. for, A (12) 330.
lime specif. for manuf. of, A (12) 331.
-lined tanks, A (10) 259.

liquid inclusions in, A (7) 186.
mach. manuf., historical account of, A (3) 79.
magnetic sepn. in plants, A (9) 237.
manuf., heat distribution for, A (9) 238.
of bottles, P (6) 167.
of, with Indian alkali, A (4) 116.
marvering, method and app. for, P (7) 188.
melting, elec. arc type fur. for, A (3) 66.
fur., P (5) 147.
smoke nuisance in, A (3) 78.
tanks, means for filling, P (11) 291.
metal joints, P (7) 189.
Glass, method and app. for making, P (11) 291.
method of treating and working, P (11) 292.
milky semi-transparent, P (11) 293.
mol. structure of, A (7) 175.
molds, heat resisting alloy for, P (7) 188.
molten, chrome alloys for app. for handling, P (8) 217.
closure for outlets for, P (12) 332.
gathering app. for, P (12) 333.
means and method for producing charges of, P (1) 23.
method and means for forming and transferring gobs of, P (11) 290.
movement in pots of, A (12) 331.
novel method of handling, A (3) 79.
stirring in continuous tank furs. of, P (11) 291.
suggested method for the detn. of the abs. viscosity of, by X-ray photographs of a falling sphere, A (12) 328.
muffle oven for decorating or annealing, P (7) 188.
multiple automatic press, P (2) 49.
nomenclature of, standardization of, A (1) 20.
non-electrolytic, P (10) 260.
nonshatterable, laminated, P (12) 332.
opal, contg. fluostannite of Mg, Ba or Pb or silico-fluorides, P (11) 293.
use of silica, alumina, fluorine compds. and bone-ash as opacifiers in, A (11) 288.
opaque to visible light, P (8) 216.
to visible rays, contg. MnO_2 and Cr_2O_3, P (9) 237.
optical, durability of, methods of detg., A (12) 329.
general description of, A (4) 116.
Japanese manuf. of, A (11) 289.
manuf. of, A (4) 111.
meas. of small variations of refractive index throughout meltings of, A (12) 328.
production and properties of, A (9) 236.
refractive indices and atmospheric press. correction, A (11) 290.
painted, firing of, A (3) 78.
passage of helium, neon and hydrogen through hot, A (1) 19.
pavement-light, P (1) 24.
plate, app. for grinding and polishing, P (1) 24.
carrying large sheets of, A (2) 48.
manuf., A (2) 48, P (7) 190.
mechanism for shifting grinding tables and, P (1) 23.
polish, P (3) 82.
polishing, by means of acid, A (6) 166.
method and appliance for, P (7) 189.
pots, action of metallic lead on, A (7) 186, A (9) 239.
care of melting, A (9) 237.
manuf. of, A (3) 79.
study on the life of, used in round pot-furs., A (11) 287.
powder, detn. of the surface of, A (9) 237.
presses, ring molds for, P (11) 292.
process of manuf. of, using natural silicates, P (5) 146.
Pyrex, chem. compn. of, A (12) 331.
graded seal for joining lead glass to, A (7) 187.
radium, X-rays and ultra-violet rays on, effect of, A (12) 328.
reflecting surfaces, manuf. of, A (10) 259.
refrac. materials, specif. for, A (12) 330.
resisting vapors of alkali metals, P (6) 167.
roll; glass on a metal roll, P (5) 146.
-rolling mechanism, P (5) 148.
sawing, app. for, P (1) 23.
scum on continuous bottle tank furs., A (3) 79
selenium as a constituent of enamels and A (11) 287.
sheet, app. for drawing, P (1) 22, P (5) 146, P (5) 147.
drawing app. and method, P (12) 332.
drawing mach., P (1) 22, P (5) 145, P (5) 148, P (12) 334.
drawing mechanism, P (7) 190.
drawing, method and app. for, P (5) 146, P (7) 188, P (12) 332.
method for producing flat parallel-shaped, P (5) 148.
surface devitrification of, A (11) 290.
sheets, compd., with org. interface, P (10) 260.
drawing, method of, P (12) 334.
Silex unbreakable, A (9) 237.
silica, double refraction and cryst. structure of, A (3) 79.
manuf. of, A (3) 80.
silver plating on, P (9) 235.
silvering surfaces of, P (8) 217.
slab, Babylonian, chem. anal. of, A (6) 155.
soda-lime-silica, detn. of sulfate-, chloride-, and carbonate-ions in, A (9) 238.
specif. for limestone, quicklime, and hydrated lime, for manuf. of, A (6) 167.
stained and painted, A (3) 71.
strains in unannealed, A (4) 115.
surfaces, prevention of steaming by treating with lubricants, A (3) 76.
tank discharging mechanism, P (1) 22.
fur., P (1) 24.
tanks, means for controlling discharge from, P (12) 334.
technology, recent advances in, A (12) 331.
telescope disc, Amer. made 40-inch, A (11) 287, A (12) 329.
thermal condy. of, effect of alumina on, A (1) 20.
thermo-luminescence in, production of, A (12) 328.
tile, antislip, P (3) 82.
construction unit, P (1) 25.
translucency of, caused by colloidal dispersion, A (11) 289.
treating fabric and emulsion, P (8) 217.
tubes, method of and app. for forming, P (5) 147.
steam gage, method of drawing, A (3) 81.
tubing and cane, drawing of, P (6) 167.
machine-drawing of, A (3) 78.
manuf. of, P (1) 23.
tumblers, specif. for lime-flint, A (12) 330.
ultra-violet absorbing, of flesh color contg. CeO_2 and MnO_2, P (10) 260.
ultra-violet light coloration of, A (12) 331.
unbreakable, A (10) 258.
under press., double refraction of, A (4) 111.
utilization of red slime in, A (2) 31.
vase, Babylonian, chem. anal. of, A (6) 155.
vials, automatic necking and bottoming mach. for, A (7) 187.
viscosity of, effect of alumina on, A (1) 20.
ware, chem., study of, A (11) 290.
mach. for making hollow, P (5) 146.
white flint, made in a tank fur., A (12) 330.
window, plate, wire and sheet, manuf. of, in the United States, A (3) 72.
wire, corrugated, machine for and method of making, P (5) 148.
working, P (6) 167.
mach., P (8) 216.
Young's modulus and time change of, A (4) 116.
Glasses, alkali-lead oxide-silica, comparison with alkali-lime-silica glasses, A (1) 20.
alkali-lime-silica, comparison with alkali-lead oxide-silica glasses, A (1) 20.
barium oxide-potassium oxide-silica, compn., d., refractive index, dispersion, weathering, soly. of, A (6) 165.
barium oxide-soda and potash-silica, compn.,

d., refractive index, dispersion, weathering, soly. of, A (6) 166.
barium oxide-soda-silica, compn., d., refractive index, dispersion and soly. of, A (4) 112.
barium oxide-soda-silica, compn., d., refractive index, dispersion, weathering, soly. of, A (6) 165.
calcium oxide-soda-silica, compn., d., refractive index, dispersion and soly. of, A (4) 112.
colored, ultra-violet and visible transmission of, A (3) 77.
with copper oxide, A (10) 258.
comparison of the alkali-lime-silica and the alkali-lead oxide-silica, A (1) 20.
compn. of, relation between d. and, A (5) 144.
contg. alumina, thermal expansion of, A (12) 328.
density of, contg. alumina, A (6) 166.
density of, relation between compn. and, A (5) 144.
density, of soda-lime-silica, soda-magnesia-silica, soda-alumina-silica, A (6) 166.
flashed, etching of, A (3) 81.
gage, steam, A (7) 187.
grinding spectacle, mach. for, P (7) 189.
heats of fusion of soda-lime-silica, A (5) 144.
high-frequency losses in, A (4) 115.
Jena, thermal expansion of, A (2) 36.
lead oxide, effect of soda and potash on the soly. of, A (12) 329.
lead oxide-soda-silica, compn., d., refractive index, dispersion and soly. of, A (4) 112.
lime-magnesia, coeff. of expansion and properties of, A (12) 327.
lime-magnesia, melting and lamp working properties of, A (12) 328.
magnesia-lime, coeff. of expansion and properties of, A (12) 327.
magnesia-lime, melting and lamp working properties of, A (12) 328.
magnesium oxide-soda-silica, compn., d., refractive index, dispersion and soly. of, A (4) 112.
opacity of, caused by colloidal dispersion of, A (11) 289.
opaque, compn. of, A (3) 77.
optical, dispersion in, A (7) 186.
historic, A (7) 186.
potash and sbda-barium oxide-silica, compn., d., refractive index, dispersion, weathering, soly. of, A (6) 166.
potash and soda-lead oxide-silica, prepn. stability, optical properties, d. and soly. of, A (3) 81.
potash-lime-silica, d., refractive index, dispersion, devitrification, soly. of, A (1) 20.
potash-lead oxide, soly. of, A (12) 329.
potash-lead oxide-silica, d. refractive index, dispersion, devitrification, soly. of, A (1) 20.
potash-lead oxide-silica, prepn. stability, optical properties, d., and soly. of, A (3) 81.
potassium oxide-barium oxide-silica, compn., d., refractive index, dispersion, weathering, soly. of, A (6) 165.
radio-protective glasses, progress in mfg., A (1) 19.
relation between d. and chem. compn. of, A (1) 19.
soda-alumina-silica, optical properties of—refractive index, dispersion and d., A (1) 21.
soda and potash-barium oxide-silica, compn., d., refractive index, dispersion, weathering, soly. of, A (6) 166.
soda-barium oxide-silica, compn., d., refractive index, dispersion, weathering, soly. of, A (6) 165.
soda-lead oxide-silica, d., refractive index, dispersion, devitrification, soly. of, A (1) 20.
soda-lead oxide-silica, prepn. stability, optical properties, d., soly. of, A (3) 81.
soda-lead oxide, soly. of, A (12) 329.
soda-lime-silica, d., refractive index, dispersion, devitrification, soly. of, A (1) 20.
soda-lime-silica, effect of selenium and cobalt oxide on the coloration of, A (12) 328.
soda-lime-silica, effect of sulphate and carbonate of sodium on heats of fusion of, A (5) 144.
soda-RO-silica, with oxides of lead, barium, strontium, zinc, calcium and magnesium as RO; compn., d., refractive index dispersion, and soly. of, A (4) 112.
sodium silicate, thermal expansion of, A (1) 21.
spectacle, mach. for grinding beveled rim, surfaces on, P (12) 332.
strontium oxide-soda-silica, compn., d., refractive index, dispersion and soly. of, A (4) 112.
thermal expansion of, contg. alumina, lime and magnesia, A (12) 328.
ultra-violet absorption of, effect of temp. upon, A (6) 165, A (7) 187.
zinc oxide-soda-silica, compn., d., refractive index, dispersion and soly. of, A (4) 112.
Glassware, alkalimetric eosin testing of, A (3) 79.
annealing of; historical, A (3) 76.
chem., an autoclave test for the grading of, A (10) 260.
conveyor for heated, P (11) 292.
ejecting mechanism, P (7) 189.
forming, mechanism for, P (7) 190.
lab. resist., tests for, A (2) 47.
-mach., P (1) 24.
mechanism for transferring, P (11) 293.
pressed, app. for manuf. of, P (1) 24.
Glasshouse pots, comparative compns. of old and new, A (12) 330.
Glassworking machs., ware steadier for, P (7) 190.
Glaze, cold, for building materials and cement, P (7) 194.
cold, for cement, P (6) 172.
defects, whiteware, and their prevention, A (1) 14.
for refrac. articles, contg. a boron oxy-compd. associated with iron and chromium, P (12) 316.
Glazes, bog iron ore, for face brick and terra cotta, A (4) 117.
cold, comparison of, and cold glazed tile with ceram. wall tile, A (8) 211.
earthenware, blow-holes in, A (1) 12.
lead, influence of fuels contg. sulfur on, A (10) 255.
peeling off of, and the scumming of whiteware, A (7) 184.
porcelain, black, A (10) 256.
high fire, A (1) 12, A (8) 211.
on the ratio of Al_2O_3 and SiO_2 to RO in high fire, A (11) 281.
relation between silica, alumina and basic oxides in, fired at high temps., A (6) 164.
silvering surfaces of, P (8) 217.
soly. of coloring metal oxides in china, A (12) 318.
spit-out of, on passing through an enamel kiln, due to bubbles of gas, A (12) 319.
stoneware, effect of sulphates on, A (3) 69.
zirconium fluoride, for porous pot ware or iron ware, A (11) 281.
Glazed ware, salt, method of burning, A (3) 59.
Gloss of paper, measuring, A (4) 98.
Glover towers, filling materials for use in, P (6) 160.
Gold, liquid, process of mfg., P (11) 269.
residues, recovery of, A (1) 12.
Granite-porcelain, manuf. of, P (11) 283.
Granulation of slag, dry, P (5) 150.
Graphical representation of igneous rocks on triangular diagrams, A (9) 231.
Graphite in Can., production of, A (12) 314.
in New Zealand, A (9) 228.
in Siberia, occurrence of, A (12) 316.
ore-deposits in Norbergs Bergslag, A (2) 37.
production of the world in 1921, A (9) 229.
recent developments in the Buckingham district, Que., Can., A (5) 134.
sepn. of mineral matter from natural flake, A (4) 107.

the liquefaction of, A (2) 40.
Greek emery exports, A (12) 317.
Grinding broken saggers, methods and app. for, A (12) 312.
closed circuit, A (12) 320.
compd., carborundum, P (5) 143.
fine. The influence of the shape of the particle, A (1) 3.
in the potteries, fine, A (12) 319.
mills, belt, gear and chain drives for, A (5) 128.
Grog products, air cracks in, A (4) 97.
Guatemala, mineral resources, limestone, graphite, mica, sulphur and niter of, A (12) 335.
Gumbotil, colloidal properties of Pleistocene clays, and their bearing on the chem. theory of the formation of, A (10) 249.
origin of, A (10) 249.
Guttameter, surface tension app. by drop wt. method, A (10) 248.
Gypsum, adsorption of water by dehydrated, A (11) 295.
and gypsum products, tent. methods of testing, A. S. T. M., A (3) 90.
as a substitute for limestone in the glass batch, A (3) 78.
calcined, cements, effect of some phys. conditions on, A (3) 90.
increasing plasticity of, P (7) 193.
chem. anal. of, method of, A (5) 149.
in British Columbia, A (9) 239.
in cements, anal. by a quick method of, A (10) 260.
industry, definitions of terms relating to, A. S. T. M., A (3) 90.
résumé of 1920, A (3) 91.
in 1920, A (2) 38.
plastering sand, tent. specif. for, A. S. T. M., A (3) 90.
report of Comm. C-11, A. S. T. M. on, A (3) 90.
rock, method of calcining, P (11) 297.
some conclusions in regard to the origin of, A (6) 160.
tent. specif. for, A. S. T. M., A (3) 90.

Hadfield-Bawtree viscometer, A (1) 7.
Handles, cup and mug, made in steel dies, A (1) 13.
Handling costs, the importance of low, A (8) 198.
devices, practical considerations of, A (8) 196.
equipment, monorail system, A (8) 211.
methods for ceram. products, A (8) 212.
Hardinge conical mill in the ceram. indus., A (12) 302.
Hardness of refractories at high temps., A (5) 139.
of refractory mats., method of detg. at high temps., A (2) 39.
testing machs. for metals, A (1) 4.
Brinell, A (1) 4.
Hase radiation pyrometer, new, A (9) 225.
Hearth furs., design of open, A (4) 108.
structures, elec. fur. conducting, stability of, A (4) 107.
Heat balance of producer gas for glass making, A (9) 238.
economy in Germany, A (4) 97.
insulating mat., P (6) 159.
mats., heat transmission coeff. of, A (10) 253.
insulation mixt., P (6) 158.
insulators, sp. heats of cork, slag wool, charcoal, wood fiber and rubber, A (8) 219.
thermal condy. of cork, slag wool, charcoal, wood fiber and rubber, A (8) 219.
interchangers, expts. with, A (7) 174.
losses in opern. of a boiler, A (12) 304.
plea for reduction in chem. plants, A (5) 131.
of combustion, constitution and, of organic compds., A (8) 197.
production in the hot zone of a continuous kiln, P (12) 305.
radiated from rotary kiln or drier, recovery of, A (10) 254.
resisting alloy, Calite, A (8) 189.
saving invest. on kilns, A (4) 106.
savings in revolving kilns, A (4) 108.
Heating channels from the ovens, A (1) 13.
curve study of rapid low-temp. reactions: barium oxides, A (4) 101.
Heats, mol., at high temps. of MgO, CaO and Al_2O_3, A (4) 100.
sp. of, heat insulators, as cork, slag wool, charcoal, wood fiber and rubber, A (8) 219.
transfer, between gases and liquids, rates of, A (8) 204.
discussion on, A (8) 203.
transmission coeff. of heat insulating materials, A (10) 253.
utilization and economy in steam power plants, A (6) 154.
waste, boilers in steel plants, A (12) 304.
installation at cement plant, A (4) 120.
Herda kiln, A (4) 106.
Heroult elec. fur., A (8) 208.
Heulandite, water content of, A (2) 35.
Hildebrand cell, prepn. of sols of silicic acid and tungsten hydroxide by means of, A (8) 202.
Hollow building tile, tent. specif. for, A. S. T. M., A (3) 87.
report of Comm. C-10, A. S. T. M. on, A (3) 87.
tile, tent. definitions of terms relating to, A. S. T. M., A (3) 87.
Hoffmann continuous kiln for firing brick, A (12) 324.
Human waste in industry, A (2) 32.
Hydraulic concn.; sepn. of feldspar and quartz, P (6) 158.
Hydrofluoric acid, soly. of silicon in, A (8) 206.
Hydrofluosilicic acid, the equilibria of, A (1) 7.
Hydrogen-ion catalysis, introduction of a catalysis coeff. in, A (10) 250.
Hydromica in kaolins, A (4) 102.

Igneous rocks, graphical representation of, on triangular diagrams, A (9) 231.
rocks, soly. of the ferromagnesian silicates in acid and basic magmas, A (7) 180.
Illinois fire clays, classification, properties and uses of, A (12) 316.
Fullers' earth deposit at Olmstead, A (7) 176.
potash shales of, A (2) 53.
Illuminants, color temp. and brightness of various, A (7) 179.
Illuminating of the interior of kilns, A (6) 162.
Incandescent burner for kerosene and heavy hydrocarbons, A (6) 156.
Incinerator for mill refuse made of brick and concrete, A (5) 129.
India, bauxite deposits in, A (12) 317.
cement industry in Punjab, A (9) 239.
china clay and fire clay in, A (12) 308.
Idar State, economic minerals of, A (5) 134.
mica in, A (10) 248.
mineral production of, 1914–1918, A (5) 134.
Indian alkali, manuf. of glass with, A (4) 116.
bauxite, A (3) 61.
Induction fur. having uni-directional circulation, P (11) 279.
Industrial research, the future of, A (11) 269.
of the Brit. Elec. and Allied Industries Research Assoc., A (11) 269.
Industry, human waste in, A (2) 32.
Information needs in science and technology, A (10) 245.
Infusorial earth, insulating material, molded with magnesia, P (7) 194.
nsulating Icompn., contg. bakelite and a polymerizable resin, P (12) 305.
compns. elec., P (4) 108.
material, contg. sillimanite, P (8) 211.
heat, P (6) 159.
made from a natural Mg silicate, P (9) 234.
molded magnesia and infusorial earth, P (7) 194.
materials, A (5) 129.
dielectric strength of varnished cloth, mica paper, micanite, etc., A (12) 321.
heat, heat transmission coeff. of, A (10) 253.
metallic layers, P (4) 121.

Insulation elec., black glass for, P (6) 167.
elec. impregnated fabric as, P (11) 269.
function of, and its application to heat-treating furnaces, A (1) 8.
heat mixt., P (6) 158.
of high-voltage transmission lines, A (7) 184.
Insulators, ceram.-spark plugs, A (1) 8.
elec., molded clay, cement, fiber compn., P (8) 220.
porcelain for, A (6) 164.
made by jigger and jolley, A (1) 13.
methods of measg. elec. resist. of, at high temps., A (1) 8.
porcelain, present demands on, A (6) 164.
proper design of, A (9) 235.
Iodometric method for detn. of copper, A (8) 205.
Iridescent effects, for manuf. of imitation mother of pearl, A (5) 143.
Iron, cast, variation of the thermal condy. with temp. of, A (8) 217.
-manganese sepn., an improved, A (5) 136.
oxide-lime-silica, system for hydraulic cements, A (12) 338.
oxides, color of glasses obtained with, A (11) 289.
-silicon system, equil. diagram of the, A (2) 35.
Isle of Wight, geology of, A (5) 134.
Italian non-metallic industries, A (10) 245.
Italy, bauxite in, deposits of, A (9) 229.
polo halite in; a saline mixt. for glass and soap industries, A (9) 228.

Japanese clays from Mount Hongo, Fukushima prefecture, used in porcelain manuf., A (11) 272.
clays from the Saga prefecture, used in porcelain manuf., A (11) 273.
fullers' earth, its properties, chem. applications, and the relation to the geological formation of petroleum, A (7) 180.
optical glass manuf., A (11) 289.
"Soma" stoneware, made from clays found in Obori, A (11) 273.
Japan, Port. cement, description of Asano Company in, A (12) 337.
present condition of ammonia-soda industry in, A (11) 268.
tunnel kilns in, A (11) 277.
Jolleying square dishes, A (1) 13.
Jugoslavia, mineral resources, bauxite, meerschaum and rock salt, in, A (10) 248.

Kaolin deposits in Finland, A (12) 309.
effect of treating, by Na polysulphide, A (2) 37.
formation and constitution of, A (5) 138.
formation in Silesia, kaolinized granite and, A (10) 248.
from Djebel Debar, Algeria, chem. compn. of, A (11) 272.
in Belgium, A (1) 8.
in North Carolina, with a brief note on hydromica, A (4) 102.
sedimentation of, effect of nonelectrolytes on, A (4) 100.
testing for whiteness of, A (8) 210.
Kaolinized feldspar, potter's clay made from, P (10) 256.
Kaolins and pottery clays in the U. S., A (4) 109.
dry purification of, A (8) 196.
Keramo—a glass building stone, A (3) 81.
Kiln, P (1) 11, P (8) 199.
adapted for burning ceram. ware, P (7) 183.
and method of operg. the same, P (2) 42.
annular, thermal "balance-sheet" of, A (4) 105.
brick, construction, P (1) 17.
burning coal fired Dutch, A (8) 214.
calcining, for Port. cement, P (2) 54.
calcining, parallel current, P (1) 12.
car-tunnel, Faugeron, A (3) 70.
cement, lighting up a modern vertical, A (8) 218.
clamp-, arch-protector for, P (5) 143.
continuous, P (7) 183.
Faugeron, in Czecho-Slovakia, A (12) 302.
heat production in the hot zone of a, P (12) 305.
highly refrac. carrier and supports for, P (12) 305.
Hoffmann, for firing brick, A (12) 324.
dry-, P (1) 3.
for burning lime or cement, P (6) 172.
furnace, P (7) 183.
gas-fired continuous, P (6) 164.
gas-fired pottery, P (12) 305.
Herda, A (4) 106.
lime, a war-time, A (4) 108.
lime-burning, P (11) 279.
lime, improved continuous-opern. pot, A (11) 297.
Marlow tunnel, A (12) 301.
porcelain, htg. by means of fuel oil, A (12) 318.
rotary, P (7) 183, P (11) 279.
for burning cement, P (11) 279.
for sintering cement slurry, P (4) 121.
lime-burning, A (2) 52, A (9) 242.
recovery of radiated heat from drier or, A (10) 254.
tunnel, P (7) 183.
an oil gas compensating, A (11) 277.
with auxiliary stacks, P (12) 305.
with sectional combustion-chambers, P (1) 11.
vol. increased by means of Minter flue system, A (10) 257.
with htg. chambers and cooling chambers, P (12) 305.
Kilns, brick, P (6) 164.
cement, excess air in, A (12) 337.
continuous, burning, A (8) 213.
continuous, for pottery manuf., A (12) 300.
heat conservation, studies on, A (8) 214.
heat saving invest. on, A (4) 106.
Hoffmann, use of liquid fuel in, A (6) 155.
revolving, heat saving in, A (4) 108.
system of, P (7) 182.
tunnel, in Japan, A (11) 277.
modern as Buch, Moller and Pfeifer, and Dressler systems, A (9) 225.
up-draft, setting and firing, A (11) 277.
Korting water jet sand washers, A (4) 98.

Laboratories, research, in indus. establishments of the U. S., including consulting research labs., A (7) 175.
Laboratory expts. to factory app., application of, A (8) 197.
Lead frits, Thorpe's soly. ratio of, A (3) 70.
glass, graded seal for joining Pyrex glass to, A (2) 47.
monoxide, hydrated, phys. chem. of, A (8) 202.
soly. of, A (4) 104.
oxide-soda-silica glasses, compn., d., refractive index, dispersion and soly. of, A (4) 112.
poisoning, review of lit. on subject of, A (11) 281.
Le Chatelier, principle of, validity of the, A (8) 204.
Leer, a novel, installation, A (6) 167.
annealing, plate glass, P (12) 333.
circular flattening, for plate glass, bottles, etc., A (4) 111.
Dixon muffle, A (3) 76.
Simplex muffle, A (3) 75.
Lens-cutting machine, glass, P (1) 21.
grinding machine, P (11) 271.
Lenses, bifocal, method of making, P (1) 22.
Leucite, cement contg., P (5) 151.
Liesegang ring formation, A (6) 161.
Lignite, crude, utilization of, for brick burning, A (6) 165.
firing with, reconstruction of grates for, A (4) 107.
Lime, action of, in magnesium oxychloride cements, A (7) 193.
and the sand lime brick industry, A (4) 118.

available, in quicklime and hydrated lime detn. of, A (2) 52.
in quicklime and hydrated lime, detn. of A (4) 119.
boiling point of, A (1) 10.
burning, A (2) 52, P (3) 92.
in the rotary kiln, A (9) 242.
kiln, rotary, A (2) 52.
with coal with high sulphur content, A (4) 118.
carbide, as a building mat., A (4) 118.
estn. of, in large quantities of magnesia, A (4) 103.
hydrated, advantages of, in paving concrete, A (8) 220.
and quicklime, detn. of available lime in, A (4) 119.
chem. anal. of, tent. methods of, A. S. T. M., A (3) 90.
for structural purposes, tent. specif. of, A. S. T. M., A (3) 89.
on concrete mixts., effect of, A (3) 89.
prepn. of, P (3) 93.
process of improving the quality of mason's, P (11) 297.
specif. for, for manuf. of glass, A (6) 167.
hydraulic, plant at Montebourg, France, A (8) 218.
in 1919, A (3) 91.
in 1920, A (4) 120.
industry, dependence of, upon nature and science, A (3) 91.
in glass batches, melting of, A (7) 186.
in glasses, effect of thermal expansion of, A (12) 328.
kiln, a war-time, A (4) 108.
for burning, P (6) 172, P (11) 279.
improved continuous-opern. pot, A (11) 297.
-magnesia glasses, coeff. of expansion and properties of, A (12) 327.
melting and lamp working properties of, A (12) 328.
producing, P (3) 92.
report of Comm. C-7, A. S. T. M., on, A (3) 89.
slaked, effect of treating, by Na polysulphide, A (2) 37.
slaking of, A (2) 52.
when mixed with sand, A (4) 118.
specif. for glass manuf., A (12) 331.
uses of, A (7) 193.
vapor pressure of, A (1) 9.
Limestone, burned lime, and slaked lime, as constituents of common glass batches contg. soda-ash and salt-cake, relative advantages and disadvantages of, A (12) 328, A (12) 329.
chem. anal. of, tent. methods of, A. S. T. M., A (3) 90.
specif. for, manuf. of glass, A (6) 167.
Lining, blast-fur., disintegration of, A (7) 181.
blast-fur., failures due to zinc, A (10) 253.
fur., merits of one piece, A (12) 314.
Liquids, internal friction of, under high press., A (2) 31.
Li_2SiO_4–Ca_2SiO_4, the system, A (1) 6, A (3) 61.
Li_2SiO_4–$ZrSiO_4$, the system, A (1) 6, A (3) 61.
Load test app. for deformation of refractories under, A (8) 207.
tests on refractory brick at high temps., A (8) 208.
Losses in pottery manuf., unestimated, A (1) 12.
Lubricants. Report of the lubricants and lubrication inquiry comm., B (2) 32.
Lubricating oils, properties of, at high press., A (2) 31.
Lubrication of ball bearings, the proper, A (2) 31.

Macedonia, chromite in Northern, A (5) 138.
Machine for producing hollow bricks, P (1) 17.
Machinery, glass, manuf. of, A (3) 79.
MacMichael torsion viscometer, A (1) 6.
Magnesia, an organism producing, A (1) 9.
boiling point of, A (1) 10.
brick, cross-breaking strength of, A (3) 67.
cement and compds., phys. properties of, A (1) 26.
flooring, theory and practice of, A (8) 218.
estn. of lime in large quantities of, A (4) 103.
expansion curves for, between 0° and 1600°C, A (6) 163.
in glasses, effect of thermal expansion of, A (12) 328.
insulating mat., molded with infusorial earth, P (7) 194.
-lime glasses, coeff. of expansion and properties of, A (12) 327.
melting and lamp working properties of, A (12) 328.
plaster, P (1) 27.
refrac. material, bonded alumina and, P (7) 183.
stone, manuf. and use of, A (2) 40.
transformation of light into dense form of, A (1) 25.
vapor pressure of, A (1) 9.
Magnesian cements, artificial stone made from Sorel, A (11) 296.
Magnesite added to body materials of talc pottery, P (11) 283.
at St. Martin, Salza, A (3) 65.
brick, load tests at high temps. on, A (8) 208.
burned, and molten magnesium chloride, molded into refrac. shapes, P (11) 279.
caustic, chemico-technical and mech. testing of, A (7) 191.
converted from dolomite, A (5) 134.
deposits in the Galgenberge, Silesia, A (5) 138.
Euboean field, A (5) 133.
extn. of calcium oxide from calcined, A (3) 66.
in conducting elec. fur. hearth structures, A (4) 107.
in sagger bodies, A (12) 321.
in so. Nevada, A (10) 247.
in W. Australia, A (3) 62.
oxychloride cements, A (7) 192.
plant of Austro-American Magnesite Co. at Radenthein, A (4) 105.
plastic calcined, and oxychloride cements, A (7) 192.
plastic calcined, for use in oxychloride cements, testing of, A (3) 88.
Magnesium carbonate from calcined magnesite, app. for producing, P (4) 105.
from calcined magnesite, prepn. of, P (4) 105.
plastic compn. of pitch and, P (12) 339.
reflection factor of, A (1) 15.
Magnesium cement, hydraulic, A (6) 169.
cements for floor coverings, P (3) 92.
chloride and burned magnesite molded into refrac. shapes, P (11) 279.
compds. used in floor coverings, P (2) 54.
hydrate, effect of treating, by Na polysulphide, A (2) 37.
limestone, used in basic refrac. compn., P (4) 108.
oxide in stoneware, effect on firing of, A (3) 60.
mol. heat capacity of, A (4) 100.
-soda-silica glasses, compn., d., refractive index, dispersion and soly. of, A (4) 12.
oxychloride cement, P (7) 193.
cements, action of lime in, A (7) 193.
wall covering or putty contg., P (11) 297.
silicate, minerals of, use of in chem. and elec. porcelain, P (3) 71.
refrac. mat. made from, P (9) 234.
Magnetic sepn. in glass plants, A (9) 237.
Malaya, new pottery industry at, A (12) 318.
Manganese and manganiferous ores in 1920, A (5) 139.
for improving color of brick, A (10) 258.
Marble, artificial, made from mixt. of colored porcelain bodies, P (11) 283.
Marlow gas-fired tunnel oven, A (12) 301.
Material for and process of forming brick, tile and the like, P (1) 17.
Mathews recuperator pot fur., A (3) 75.
Mazout fuel oil for lime kilns, A (3) 88.

Measuring app., improvements in; review of German patents, A (9) 225.
Meerschaum, artificial, A (3) 50, P (6) 158.
in Jugoslavia, A (10) 248.
Meissen, Royal, porcelain for pottery and chem. ware, firing temp. of, A (3) 71.
Melting points, simple method for detn. of, and critical temps., A (8) 202.
Merwinite, a new calcium magnesium orthosilicate from Crestmore, California, A (7) 180.
Metals, temp. coeffs. of elec. conductance of pure, A (7) 180.
Metasomatism in siliceous rocks, A (6) 160.
Metric standardization, progress in, A (8) 198.
Meurer enamel spraying process, A (3) 85.
$MgCa(SiO_3)_2$, m. p., sp. gr., and refractive indices of, A (3) 63.
$MgSiO_3$, m. p., sp. gr., refractive indices of, A (3) 62.
Mg_2SiO_4, m. p. of, A (3) 62.
Mica, elect. resist. of, at high temps., A (1) 8.
glass contg. asbestos or, P (7) 188.
high-frequency losses in, A (4) 115.
(in India), indus. uses of, A (10) 248.
use of in glass compn., P (5) 146.
Micelle, the conception of, in colloid chemistry, A (12) 311.
Microscope heating, for high temps., A (2) 35.
Microscopic arrangement for the examn. of opaque crystals, A (10) 247.
Mineral industries, importance of U. S., A (5) 128.
production of India 1914–1918, A (5) 134.
resources as limestone, graphite, mica, sulphur and niter of Guatemala, A (12) 335.
of New York State, A (3) 65.
sepn. by flotation, review of German patents on, A (5) 129.
Minerals, calcn. of the boiling pts. of, A (2) 37.
economic, of Idar State, India, A (5) 134.
indus. and structural, A (10) 245.
Mineralogy, economic, A (8) 202.
recent advances in chem. of, A (12) 311.
Minter flue system for increasing kiln vol., A (10) 257.
Mirrors, with embedded metallic reflecting surface, P (3) 82.
$MnSiO_3$, m. p., sp. gr., and refractive indices of, A (3) 63.
Mn_2SiO_4, m. p., sp. gr., and refractive indices of, A (3) 63.
Moisture, app. for detn. of, A (5) 132.
Mold, plastic-block, P (7) 177.
with collapsible core sections, P (12) 327.
Molding earthenware, P (9) 235.
sands: their origin and uses, A (5) 136.
Molds, combination blank and finishing, for glass articles, P (2) 49.
plaster, poured versus pressed, A (2) 31.
Molecular force and plasticity of clay, A (1) 7.
structure of amorphous solids, A (7) 175.
Moore gas producing system, A (5) 141.
Mortar, cement, relation of length of iron reinforcement and the setting of, A (2) 52.
contg. diatomaceous earth, clay, etc., P (12) 316.
yellow or white blast fur. slag, P (11) 297.
influence of, on wall strength, A (4) 118.
sand-lime, properties of, A (9) 242.
throwing app. for plastering walls, P (12) 339.
Mortared smoke stack, failure of a, A (5) 128.
Mortars, cement, behavior of, in sulfate-bearing waters, A (2) 50.
cement, relation between tensile and compressive strengths of, A (2) 51.
vol. alteration of, on setting, A (2) 52.
hydraulic, strength of, using substitutes of natural rocks, org. compds. and other materials for sand, A (9) 240.
immersed in sea water 15 years, tests on concrete and, A (10) 261.
of fire clay and fire-clay grog, A (2) 39.
of ground silica brick and clay firebrick mixts., A (2) 39.
Port. cement, shrinkage of, and its importance in stucco construction, A (4) 120.
processes which occur during the formation of, A (6) 169.
rendered waterproof, adhesive and quick-setting, P (5) 150.
Muffle leer, Dixon, A (3) 76.
leer, Simplex, A (3) 75.
oven, elec., for temps. up to 1350°, A (2) 41.
oven for decorating or annealing glass or enamel ware, P (7) 188.

Na_2SiO_3, heat liberated by the formation of A (5) 144.
Nevada, magnesite in southern, A (10) 247.
New Jersey, clays of Mercer County, A (12) 309.
new ceram. station at Rutgers College, State University of, A (12) 302.
New York state, mineral resources of, A (3) 65.
New Zealand, clay in, A (9) 228.
fullers' earth in, A (9) 228.
graphite in, A (9) 228.
talc, occurrences of, in, A (9) 228.
Nickel-chromium alloys, thermal expansion of, and chromium over an extended range of temps., A (8) 197.
Non-slip surfaces, contg. cement and silicon-carbide, A (11) 296.
Norbergs Bergslag, graphite ore-deposits of, A (2) 37.

Ochers, mineral, comments on various methods of attacking, A (5) 138.
Ohio ceram. industries, glimpses of, A (1) 3, A (2) 43.
Oil burning in a ceram. plant, A (12) 302.
burning in Haigh kiln, A (8) 213.
interpreting carbon dioxide content of flue gas in, A (11) 267.
vs. coal burning for drain tile, A (11) 276.
fuel, htg. a porcelain kiln by means of, A (12) 318.
fuels, combustion of, in kilns, A (12) 301.
-gas fur., description of, A (12) 301.
Mazout, for fuel in lime kilns, A (3) 88.
purifier, A (4) 97.
Oils, lubricating, properties of, at high press., A (2) 31.
mineral, improvement of the lubricating properties of, A (2) 32.
Ontario, clays and sands of Northern, A (5) 137.
fluorspar deposits of Madoc Dist., A (5) 137.
min. and ore deposits of, A (5) 137.
sands and clays of, Northern, A (5) 137.
soapstone in, new source of, A (9) 227.
Opacifier for alabaster glass, as fluorine compds. and asbestos, A (11) 289.
for glass, compns. of, A (3) 77.
for glass, fluostannite of Mg, Ba or Pb as, P (11) 293.
for opal glass, as silica, alumina, fluorine compds. and bone-ash, A (11) 288.
Opacity agents for enamels, A (11) 294.
agents for enamels as oxides of tin, antimony, zirconium, cerium, lead, zinc and arsenic, and other compds., A (11) 294.
of glasses, caused by colloidal dispersion, A (11) 289.
Opal glass contg. fluostannite of Mg, Ba or Pb or silico-fluorides, P (11) 293.
Opal glass, use of silica, alumina, fluorine compds., and bone-ash as opacifiers in, A (11) 288.
Opaque glasses, compn. of, A (3) 77.
Optical glass, general description of, A (4) 116.
glass manuf. of, A (4) 111.
the manuf. of, and of optical systems, B (3) 93.
weathering of, methods of detg., A (12) 329.
problems in glass making, A (12) 331.
pyrometer, new, "Ardometer" for high temps., A (5) 132.
pyrometers, method of operg., P (4) 115.
Orsat app. for flue-gas anal., modified, A (10) 249.
Osmosed clays, A (3) 58.
Osmosis, electro-, applications to industry of, A (10) 245.
technical application of, A (8) 198.

Oxides of metals, dissociation press. of, A (4) 103.
Oxychloride, calcium, lime and plaster of Paris as a plastic compn., P (8) 220.
cement, magnesium, P (7) 193.
manuf. of, P (3) 92.
cements, magnesite, A (7) 192.
magnesium, action of lime in, A (7) 193.
testing of plastic calcined magnesite for, A (3) 88.
of magnesium, wall covering or putty contg., P (11) 297.
zirconium, and zirconium oxide, physico-chem. anal. of sols of, A (4) 104.
Oxydisiline, Si_2H_2O, A (3) 61.

Particle-size anal. of granular and powd. mats., A (7) 180.
Pastes, liquid ceram., P (7) 193.
Patent law, influence of, on the evolution of research, A (10) 246.
legislation and the chem. industry, A (7) 175.
Patents and indus. research, A (7) 176.
current chem. and patent problems, A (10) 246.
relation of employer and employee as regards ownership of, A (10) 246.
Paving brick, P (5) 144.
brick variety simplified, A (8) 212.
roads with "Pontam" reinforcements of cast iron depressed frames, A (12) 323.
Pearl beads, a new method of coating, A (3) 72.
Permutites, basic changes in A (3) 61.
the equilibria of, A (2) 37.
Peru, Central, vanadiferous asphaltites of, A (9) 233.
Phonograph needles of shale or clay, P (9) 225.
Phosphate-rock calcining process, P (5) 132.
Phosphorescent and fluorescent compds., prepn. of, A (11) 276.
Pintsch-generator gas plant, and results of opern. with different fuels, A (5) 130.
Pipe, clay, a bituminous compd. for jointing, A (10) 258.
dark colored, from fire clay, A (8) 212.
sewer, causes of blisters on, A (12) 325.
developing the reddish brown color in, A (12) 324.
firing of, A (10) 257.
report of Comm. C-4, A. S. T. M., on, A (4) 86.
Pipes, cement, impermeable, A (4) 118.
concrete, app. for forming, P (12) 339.
stoneware, A (4) 110.
Pipettes, note on draining of, A (12) 306.
Plaster bricks, light, A (4) 118.
casts, sepn. compn. for P (8) 220.
cements, the porosity strength and absorbing power of, A (4) 118.
chem. anal. of, method of, A (5) 149.
compn., P (7) 193.
magnesia, P (1) 27.
mixt. contg. ashes, plaster of Paris, etc., P (11) 297.
molds, poured versus pressed, A (2) 31.
molds, utilization of, A (4) 118.
of Paris, building mat. from, P (4) 122.
plastic compn., of glycerine, water and, P (12) 338.
supports for walls, P (12) 339.
Plastic articles, method and mach. for forming impressions in, P (7) 193.
-block mold, P (7) 177.
compn. and process for making same, P (7) 177.
of calcium oxychloride, lime and plaster of Paris, P (8) 220.
of glycerine, plaster of Paris and water, P (12) 338.
of pitch and magnesium carbonate, P (12) 339.
flow and viscous deformation, A (3) 64.
through capillary tubes, A (3) 64.
Plasticity. Fluidity and Plasticity, B (6) 172.
of clay, mol. force and, A (1) 7.
of clays, A (2) 36, A (11) 284.
of clays, mixt. of electrolytes for obtaining, P (5) 131.
Plastering walls, with mortar throwing app., P (12) 339.
Plastometer, Bingham variable press., A (1) 6.
Plate glass and grinding tables, mechanism for shifting, P (1) 23.
annealing leer, P (12) 333.
casting, method of, and app. for, P (5) 147.
process of making, P (5) 148.
Plate-making mach., A (1) 13.
Plauson colloidal mill, A (2) 34.
Polish for glass, P (3) 82.
for glass or metals, P (3) 82.
Polo halite in Italy; saline mixt. for glass and soap industries, A (9) 228.
"Pontam" system of paving roads with cast iron depressed frames, A (12) 323.
Porcelain, chem. and elec., use of min. composed of $MgSiO_3$ in, P (3) 71.
Chinesisches Porzellan, B (2) 45.
chromatics and its application to painting, A (11) 280.
colored, artificial marble made from mixt. of bodies of, P (11) 283.
elec. Die Geschichte der Porzellanfabrik zu Tettau, B (7) 184.
Die Porzellan-Isolatoren, B (7) 184.
elec. tests for porosity of, A (11) 283.
research, A (11) 282.
resist. of, A (1) 15.
resist. of, at high temps., A (1) 8.
testing of, in Germany, A (8) 211.
use of $ZrSiO_4$ in, A (1) 14.
zircon spark plug, A (12) 321.
firing of, in tunnel- and round kilns, A (11) 280.
fittings for wireless, A (12) 317.
for elec. insulators, A (6) 164.
glazes, black, A (10) 256.
glazes, high fire, A (1) 12, A (8) 211.
high fire, on the ratio of Al_2O_3 and SiO_2 to RO in, A (11) 281.
relation between silica, alumina and basic oxides in, fired at high temps., A (6) 164.
granite-, manuf. of, P (11) 283.
high tension insulator, discussion of, A (4) 111.
insulators, baking, P (2) 45.
impregnating cements for, A (2) 44.
modern production of, A (2) 45.
phys. and mech. testing of, A (2) 43.
present demands on, A (6) 164.
proper design of, A (9) 235.
Japanese, chem. compn. of clays used in the Fukushima prefecture, A (11) 272.
chem. compns. of clays used in the Saga prefecture, A (11) 273.
lab., tests for, A (2) 44.
manipulation—dental ceramics, A (2) 31.
mech. tests for raw mats. used in the manuf. of, A (11) 283.
Meissner Porzellan, B (10) 256.
modern developments in German, A (12) 321.
pottery and chem., firing temp. of Royal Meissen, A (3) 71.
silver plating on, P (9) 235.
teeth, process for fixing tacks to, P (11) 284.
tensile strength of, A (1) 15.
method of detg., A (3) 69.
testing for whiteness of, A (8) 210.
thermal expansion of, A (2) 36.
translucency of, A (12) 318.
transparency of, affected by the type of silica included, A(11) 280.
Porosity of Brit. fire clays after being fired at high temps., A (6) 166.
of elec. porcelain, elec. tests for, A (11) 283.
Portland Cement, B (2) 54.
accelerated test of, A (6) 169, A (11) 295.
and calcining kiln, P (2) 54.
and limewater, equil. between, A (1) 26.
and trass, A (4) 118.
Canadian stand. specif., A (9) 239.

comparison with blast-fur. cement, A (7) 192.
concrete, some causes of cracking and disintegration of, A (12) 338.
critical review of wet process of manuf., A (4) 120.
crystn. processes and transformations in the hardening of, A (3) 91.
description of Asano Company in Japan, A (12) 337.
equil. between limewater and, A (1) 26.
interpreting the chem. anal. of, A (3) 91.
its testing and specif., A (5) 149.
Japanese stand. rules for testing, A (5) 149.
judging the quality of, A (2) 51, A (7) 193.
manuf. of, by rotary grate shaft kiln, A (11) 296.
mortars, shrinkage of, and its importance in stucco construction, A (4) 120.
plant at Lourenco Marques (South Africa), A (10) 260.
plant at Montebourg, France, A (8) 218.
special high resist., A (2) 49.
theories of constitution and hydration of, A (12) 338.
wet process for manuf. of, A (2) 52.
Portugal, whiteware potteries in Spain and, A (3) 70.
Potash for fertilizer made from feldspar as a ferrosilicon, A (12) 309.
from feldspar, A (9) 230.
from silicates, prepn. of, A (9) 236.
recovery from cement kilns, A (7) 192.
shales of Illinois, A (2) 53.
Potassium compds. from cement-kiln gases, P (3) 93.
compds., recovering, in cement manuf., P (4) 122.
comprns., prepn. of, from feldspar and similar comprns., P (6) 162.
sulphate, from alunite, P (6) 163, P (6) 164.
volumetric estn. of, by tartrate method, A (12) 310.
Pot fur. conditions, proper control of, A (11) 287.
melting, detachable puddle rod and blade, P (9) 226.
Pots, glass, action of iron and other metals upon clay, A (9) 237.
glass, action of metallic lead on, A (7) 186, A (9) 239.
manuf. of, A (3) 79.
melting, care of, A (9) 237.
study on the life of, used in round pot-furs., A (11) 287.
glasshouse, comparative comprns. of old and new, A (12) 330.
Pottery clays in Can., location of, A (11) 273.
decorating, process for, P (11) 283.
examples of W. Australian, A (12) 319.
industry at Malaya, A (12) 318.
manuf. of, P (2) 47.
continuous kilns for, A (12) 300.
general description of, A (12) 317.
The Potter's Craft, B (12) 340.
ware, app. for manuf. of, P (11) 284.
Pozzuolanous substances, application of ferriferous agglomerate in presence of, A (1) 25.
Precipitation, elec., A (9) 225.
elec. dust pptn., A (6) 161.
of cement mill dust, A (8) 196.
of suspended particles from gases, app. for P (6) 159.
Presspan, high-frequency losses in, A (4) 115.
Pressure, high, internal friction of liquids at, A (2) 31.
what happens under a press. of 300,000 lbs. per sq. in., A (5) 133.
Problems in potting, some unsolved, A (3) 70.
Producer gas, anal., graphical treatment of stack and, A (9) 225.
gas, cleaning without washing, A (9) 233.
detn. of carbon monoxide and carbon dioxide in, A (5) 130.
plant design, A (9) 224.
process, low-temp. by-product recovery, A (10) 245.
some critical observations on the generation of, A (6) 157.
water-gas, continuous, A (6) 157.
Pulverization of fuels, A (10) 245.
Pulverizer, Turbo, for powdered fuel, A (6) 156.
Pulverizing anthracite coal, A (6) 154.
Pulverizing, crushing and storing, mech., A (11) 269.
Pyrex: a triumph for chem. research in industry, A (9) 236.
glass, chem. compn. of, A (12) 331.
graded seal for joining lead glass to, A (2) 47.
Pyrometer, Brown cold junction compensated, A (7) 178.
construction, standardization and opern. of, A (2) 33.
disappearing filament, A (9) 225.
filaments, current-temp. relation for tungsten and carbon, A (4) 98.
installation in a works, some of the difficulties encountered in maintaining, A (11) 265.
optical "Ardometer," for high temps., A (9) 132.
use of in practice, A (8) 200.
with disappearing filament free from diffraction effects at the filament, A (12) 305.
possibilities, A (12) 306.
radiation, A (6) 159.
Ardometer, A (11) 271.
of Hase, A (9) 225.
setting a recording, for cold-junction temp., A (7) 179.
system, difficulties encountered in the installation of a, A (8) 199.
Pyrometers, optical, method of operg., P (4) 115.
Pyrometry: A practical treatise on the meas. of high temps., B (1) 6.
optical, 1920 report of Comm. on, A (8) 200.

Quarrying slate, scien. method of, A (10) 244.
Quartz, atomic grouping and optical rotation of, A (4) 100.
comparison of Amer. and German flint and, used in the ceram. industries, A (12) 311.
fused, as grog in saggers, A (3) 71.
glass. See silica glass.
heat of crystn. of, A (8) 215.
high-frequency losses in, A (4) 115.
into tridymite, influence of substances on transformation of, A (3) 60.
reversible thermal expansion of, A (5) 141.
thermal expansion of, A (2) 36.
uses of, A (5) 134.
Quartzite, effect of htg. on the properties, of, A (12) 307.
Quicklime for stand. purposes, tent. specif. for A. S. T. M., A (3) 89.
specif. for, for manuf. of glass, A (6) 167.

Radiation elec. glass fur., A (9) 236.
Radium on glass, effect of rays from, A (10) 259, A (12) 328.
Rational anal. of clays as a plant control, A (8) 214.
Reactions at high temp. under press., app. for, as cracking hydrocarbons, P (11) 271.
Reflecting surface, mirrors with embedded metallic, P (3) 82.
a discussion of the making of, B (1) 27.
manuf. of, A (10) 259.
Reflection factor, meas. of, by use of Ulbricht sphere, A (1) 15.
Refraction, double, in glass, meas. of, A (6) 166.
double, of glass under press., A (4) 111.
Refractive index, of barium oxide-potassium oxide-silica glasses, A (6) 165.
of barium oxide-soda-silica glasses, A (6) 165.
of barium oxide-soda and potash-silica glasses, A (6) 166.
of optical glass meltings, meas. of small variations of, A (12) 328.
of potash-lead oxide-silica, soda-lead oxide-silica, potash and soda-lead oxide-silica glasses, A (3) 81.

of potash-lime-silica, soda-lime-silica, potash-lead oxide-silica, soda-lead oxide-silica glasses, A (1) 20.
of RO-soda-silica, with oxides of lead, barium, strontium, zinc, calcium and magnesium as RO glasses, A (4) 112.
of soda-alumina-silica glasses, A (1) 21.
Refractometry of liquids at high temps., silica-glass prism for, A (4) 116.
Refractories, carborundum, in heat-treating furs., A (2) 40.
cross-breaking strength of chrome, bauxite, magnesia, fire clay, silica and carborundum brick, A (3) 67.
deformation of, app. for detn. of under load, A (8) 207.
for elec. furs., A (4) 107.
gas works, chem. and phys. of, A (9) 233.
gas works and coke oven, A (6) 163.
hardness of, at high temps., A (5) 139.
improved by research, A (10) 251.
in the steel plant, A (4) 107.
jointing mats. for, A (2) 38, A (12) 315.
lab. fur. for deformation temp. of, A (8) 209.
mortars for, A (2) 38.
notes on Amer. practice in, A (11) 277.
report of Comm. C-8 A. S. T. M. on, A (3) 66.
source of troubles, A (8) 209.
Refractory article having coating of an oxy-compd. of boron, associated with iron and chromium, P (12) 316.
articles, and abrasive, P (11) 280.
basic compn. of magnesium limestone, P (4) 108.
bodies for temps. over 2000° in furs. with reducing atmospheres, A (9) 233.
of ZrO_2, BeO and MgO for temps. over 2000° in furs. with reducing atmospheres, A (9) 233.
brick, P (8) 210.
basic, P (5) 142, P (7) 182.
for blast furs., A (3) 66.
load tests at high temps. of fire clay, silica and carborundum, A (11) 277.
the after-contraction test on fire and silica, A (11) 278.
in the German Navy, war experience with, A (4) 107.
under load at high temps., behavior of clay, magnesite, silica and carbon, A (8) 208.
cements and protective coatings, A (11) 276.
compn., P (8) 210.
acid proof, P (1) 11.
of fused alumina or silica, graphite and fluxes, P (10) 254.
of silicon carbide, graphite, and fluxes, P (10) 254.
of zircon and clay, P (10) 255.
of zircon and clay binder, P (3) 68.
of zirconium oxide and steatite, P (11) 280.
ZrO_2 and steatite for spark plugs, etc. C. A. French, U. S. 1,418,648, P (11) 280.
cover for elec. furs., P (8) 201, P (9) 234.
crucibles, mfg., A (4) 106.
fire-clay heat insulating mat., P (3) 68.
mat., aluminothermic corundum as a, A (2) 40.
basic, P (1) 11.
made with a natural Mg silicate, P (9) 234.
of bonded magnesia and alumina, P (7) 183.
of burned magnesite and molten magnesium chloride, P (11) 279.
of carborundum with Zr and Al silicates, P (3) 68.
of mixt. of zirconia and alumina, P (4) 108.
materials, the after-contraction test of, A (5) 141.
expansion of bricks of fused bauxite, clay, silica, chromite, and magnesia between 0° and 1600°C, A (6) 163.
Fuels and Refractory Materials, B (12) 316.
influence of oxidizing and reducing atmospheres on, A (2) 39, A (12) 315.
made from the residue remaining from the concn. of chrome ore, P (11) 280.
manuf. and use of, A (2) 40.
method of detg. hardness of, at high temps., A (2) 39.
progress report of Amer. Gas Association, A (5) 140.
Research Comm., report of British, A (11) 278.
resist. tests on, at different temps., A (11) 277.
Schamotte, Dinas stone, magnesia stone, manuf. and use of, A (2) 40.
specif. for glass, A (12) 330.
standardization of the after-contraction test, A (11) 278.
thermal condy. at high temps. of, A (11) 278.
thermal condy., sp. heat, d. and thermal expansion of, A (8) 208.
under load at high temps., behavior of, A (2) 39.
products industry, A (4) 107.
protective coating on fur. linings, carborundum-sodium silicate mixt., P (4) 109.
sillimanite, brick, A (8) 208.
Regenerator chambers, new method of setting, A (3) 73, A (3) 74.
Research, benefits of technical and scien., A (11) 266.
indus., and patents, A (7) 176.
benefits of, A (2) 32.
of the Brit. Elec. and Allied Industries Research Assoc., A (11) 269.
the future of, A (11) 269.
influence of patent law on the evolution of, A (10) 246.
is tool which will improve refrac., A (10) 251.
lab., enameled products, A (3) 85, A (7) 191.
labs. in indus. establishments of the U. S., including consulting research labs., A (7) 175.
scientific, the place of, in the programs of trade associations, A (11) 269.
the factor of safety in, A (10) 245.
Resistances, elec., method of protecting, P (3) 68.
Retorts for zinc ores, A (8) 208.
Rhodesia, asbestos production in, A (12) 307.
Ring molds for glass presses and the like, P (11) 292.
Road mats., stand. and tent. methods of sampling and testing, A (12) 338.
Rocks, thermal condy., sp. heat, d. and thermal expansion of, A (8) 208.
Roofing tile, P (5) 143.
concrete, means for use in manuf. of, P (7) 194.
Roofs, fur., baked in position, P (7) 183.
Ruby glass, copper, for casing, A (4) 111.
Russian fire-clay concern, A (9) 223.

Sagger bodies, tests on, contg. magnesite, corundum, zirconium oxide and carborundum, A (12) 321.
Saggers, carborundum as grog in, A (3) 71; fused quartz as grog in, A (3) 71.
grinding broken, methods and app. for, A (12) 312.
Salt glazed ware, method of burning, A (3) 59; rock, in Jugoslavia, A (10) 248.
the blue flame produced by, on a coal fire, A (11) 269.
Salza, magnesite at St. Martin, A (3) 65.
Sand, foundry, P (8) 199.
gypsum plastering, tent. specif. for, A. S. T. M., A (3) 90.
in hydraulic mortars, variation in strength due to substitution of natural rocks, org. compds. and other mats. for, A (9) 240.
lime brick. See Brick, sand lime.
lime mortar, properties of, A (9) 242.
washer, A (2) 34.
washers, water jet, Korting, A (4) 98.
Sands, molding, their origin and use, A (5) 136.
of Northern Ontario, A (5) 137.
Schamotte, manuf. and use of, A (2) 40.
Schone's app., modification of, A (1) 13.

Scum on continuous bottle tank furs., A (3) 79.
Scumming, barium fluoride used to prevent, A (8) 212.
in brick, causes of, A (8) 213.
of whiteware and the peeling off of glazes, A (7) 184.
Seger cones in coal gas, behavior of, A (1) 9.
Segregation as it applies to tanks as segregating or mixing devices, A (12) 337.
Selenium, colloidal, note on, A (5) 134.
for enamels and glass, use of, A (11) 287.
in soda-lime-silica glasses, coloration effect of, A (12) 328.
red, coloring properties of cadmium red and, A (11) 286.
Separating solid mats., P (9) 226.
Separation of liquids and solids by the Avrutik continuous and automatic shifting process, A (1) 4.
Separator, centrifugal, P (6) 159.
Serpentine and chromite refrac. brick, P (8) 210.
Sewer and clay pipe, report of Comm. C-4, A. S. T. M. on, A (3) 86.
clay brick, tent. specif. for, Comm. C-3, A. S. T. M., A (3) 86.
pipe, blisters on, causes of, A (12) 325.
developing the reddish brown color in, A (12) 324.
firing of, A (10) 257.
Shale, bearings of vitrified, P (4) 97.
-oil, condenser, P (7) 177.
Shales, potash, of Illinois, A (2) 53.
Sheet glass. See Glass, sheet.
Shrinkage of British fire clays after being fired at high temps., A (6) 166.
Siberia, graphite deposits in, A (12) 316.
Sicilian sulfate of soda, A (9) 229.
Sieves, Schubert and Schuchard jig, critical invest. of, A (5) 131.
SiH_2Cl_2, prepn. of, A (3) 64.
SiH_3Cl, prepn. of, A (3) 64.
Silesia, kaolin and kaolinized granite formation in, A (10) 248.
magnesite deposits in the Galgenberge, A (5) 138.
Silex unbreakable glass, A (9) 237.
Silica, alumina, colloidal system of, A (2) 35.
amorphous pptd., effect of htg. on properties of, A (12) 307.
as an opacifier for opal glass, A (11) 288.
boiling point of, A (1) 10.
brick, cross-breaking strength of, A (3) 67.
effect of htg. on the properties of, A (12) 308.
effect of impurities on, A (2) 40.
for coke ovens, A (4) 107.
load tests at high temps. on, A (8) 208, A (11) 277.
of const. vol., A (8) 207.
prepg. high-grade, from quartzite rock, A (3) 67.
process of manuf. by adding acid radicals for rapid conversion, P (12) 316.
specif. for, A (12) 330.
the after-contraction test of, A (5) 141, A (11) 278.
expansion curves for, between 0° and 1600°C, A (6) 163.
films, drawing, P (4) 108.
for the glass indus., German sources of, A (3) 73.
fused, elec. resist. of, at high temps., A (1) 8.
gas adsorption by, A (4) 102.
gel, heat of wetting of, A (5) 135.
properties of, A (10) 244.
glass, dielectric anomalies of, A (10) 257.
double refraction and cryst. structure of, A (3) 79.
effect of htg. on the properties of, A (12) 307.
manuf. of, A (3) 80.
prism for refractometry of liquids at elevated temps., A (4) 116.
stability relationships of the silica minerals and, A (8) 215.
influence of, on annealing temp. of glass, A (3) 76.
in 1920, A (3) 65.
minerals, at. grouping and optical rotation of, A (4) 100.
heat of crystn. of cristobalite, quartz and chalcedony, A (8) 215.
mean sp. heats of the, A (8) 215.
reversible thermal expansion of, A (12) 307.
stability relationships of silica glass and the, A (8) 215.
reversible thermal expansion of, A (5) 141.
sand operns., Calif., A (9) 234.
vapor press. of, A (1) 9.
volatilization of, under reducing atmosphere at high temps., A (12) 312.
Silical bromide, Si_2OHBr, A (3) 61.
hydroxide $(Si_2OH)OH$, A (3) 61.
radical Si_2OH, A (3) 61.
Silicate cements, P (4) 121.
glasses, thermal expansion of sodium, A (1) 21.
of soda, properties of commercial, A (9) 223.
ultramicroscopic examn. of, A (2) 38.
of sodium, effect of, on swelling and gelation of gelatin, A (3) 60.
notes on, A (6) 160.
Silicates, alkali, P (1) 3.
basic, changes in, A (3) 61.
decompn. of, P (2) 38.
formed with complex cobaltic compds., A (3) 63.
heat liberated by the formation of sodium and calcium, A (5) 144.
m. p., sp. gr., and refractive indices of Be, Ba, Ca, CaMg, Cd, Mg, Mn, Zn, A (3) 62.
sol., prepn. of, A (3) 65.
Silicic acid, a new method for detg., A (5) 135.
as a medicine, A (4) 100.
centrifugal method for prepg. colloidal, A (10) 251.
colloidal, invest. of prepn. of, A (8) 203.
gelatinization of, effect of tungstic acid on, in strong hydrochloric acid soln., A (8) 203.
introduction of, into nucleus of complex compds., A (3) 63.
organogels of, A (5) 135.
sols, prepn. of, with help of Hildebrand cell, A (8) 202.
studies on the gel of, A (4) 102.
Silicide of calcium—a new deoxidizing agent, A (2) 36.
Silicon-carbide and cement mixts. for non-slip surfaces, A (11) 296.
chemistry, A (2) 36.
compds., some unsatd., A (3) 60.
-hydrides, A (3) 64.
-iron system, equil. diagram of, A (2) 35.
soly. in hydrofluoric acid of, A (8) 206.
Silicone, A (3) 61.
Sillimanite, insulating mat. contg., P (8) 211.
refrac. brick, A (8) 208.
Silver plating on porcelain or glass, P (9) 235.
Simplex muffle leer, A (3) 75.
Simplified practice for eliminating waste in paving brick, A (12) 322.
Slag, basic, chem. anal. of, A (8) 202.
basic, manuf. in Great Britain, A (12) 312.
brick, A (3) 87.
building brick, manuf. of, A (2) 46.
cement, blast-fur., A (2) 50.
use of in construction work, A (12) 338.
dry granulation of, P (5) 150.
fusibility of open-hearth, contg. titanium dioxide, A (7) 182.
hollow building tile from, A (9) 235.
Slags, blast fur., color classification of, A (8) 201.
blast-fur., hydraulic setting properties of basic, A (12) 338.
researches with, A (6) 170.
iron blast fur., and their uses as building material, A (8) 219.

Slaking of lime, A (2) 52.
when mixed with sand, A (4) 118.
Slate, artificial, P (4) 98.
quarrying, scien. method of, A (10) 244.
Smoke nuisance in glass melting, A (3) 78.
prevention in pottery kilns, A (11) 282.
Soapstone in Ontario, new source of, A (9) 227.
Soda-alumina-silica glasses, optical properties of refractive index, dispersion, and d., A (1) 21.
ash, light, in flint bottle glass, A (3) 79.
industry in Japan, present condition of, A (11) 268.
Sodium chlorate, at. grouping and optical rotation of, A (4) 100.
silicate, effect of, on swelling and gelation of gelatin, A (3) 60.
glasses, thermal expansion of, A (1) 21.
notes on, A (6) 160.
solns., relation of structure to free alkali in, A (2) 38.
sulfate, Sicilian, A (9) 229.
Soil anal., phenomena of layer formation in clay suspensions and their application to, A (7) 175.
Soils, flocculation of, A (6) 171.
relation between the clay content and certain phys. properties of, A (6) 171.
Solidification and fusion, influence of surface tension on, A (1) 7.
Sols of silicic acid and tungsten hydroxide with the help of the Hildebrand cell, A (8) 202.
Solubility of glasses, barium oxide-potassium oxide-silica, A (6) 165.
of glasses, barium oxide-soda and potash-silica, A (6) 166.
of glasses, barium oxide-soda-silica, A (6) 165.
of glasses, potash-lead oxide-silica, soda-lead oxide-silica, potash and soda-lead oxide-silica, A (3) 81.
of glasses, potash-lime-silica, soda-lime-silica, potash-lead oxide-silica, soda-lead oxide-silica, A (1) 20.
of glasses, RO-soda-silica, with oxides of lead, barium, strontium, zinc, calcium, and magnesium as RO, A (4) 112.
of lead frits, Thorpe's, A (3) 70.
Sorrel cements, artificial stone made from magnesian, A (11) 296.
Sound-proof partitions, A (9) 242.
Spain, bauxite deposits in, A (8) 209.
whiteware potteries in Portugal and, A (3) 70.
Spalling of fire-clay brick, tent. method of testing resist. to, A (3) 66.
Spark plugs, ceram. compns. of, A (1) 9.
properties and prepn. of ceram. mats. for, A (1) 8.
Specific heat of refrac. materials and rocks, A (8) 208.
of solids at high temps., A (9) 230.
Specific heats of solids, simple formula for calcn. of, A (9) 232.
studies on, A (9) 231.
Spinel type of copper aluminate, a hitherto unknown, A (1) 6.
$SrSiO_3$, m. p., sp. gr., and refractive indices of, A (3) 62.
Sr_2SiO_4, m. p. of, A (3) 62.
Stack calcns., simplified, A (8) 197.
Stains in whiteware bodies, use of, A (12) 321.
Stalagmometer, surface tension app. by drop wt. method, A (10) 248.
Stanniferous faience, making of, A (8) 210.
Steam meters for sand-lime brick works, A (4) 118.
Steatite, and zirconium oxide used as a refrac. compn., P (11) 280.
Steels, gun and fine, acid open-hearth process for manuf. of, A (8) 208.
Stone, acid-proof, A (6) 170.
artificial, P (4) 121, P (6) 165.
made with magnesian (sorrel) cements, A (11) 296.
natural, the rate of expansion and contraction of wet and dried, A (2) 52.
Port.-cement mortar artificial, P (5) 150.
preservation of, A (10) 244.
water-proofing natural, P (5) 150.
X-ray tests for, A (10) 244.
Stoneware body for elec. insulators, A (4) 111.
cooking utensils, A (4) 110.
effect of CaO and MgO on firing of, A (3) 69.
glazes, effect of sulphates on, A (3) 69.
Japanese, from the village of Obori, making "Soma," A (11) 273.
machs., pumps and exhausters, A (3) 71.
or clay utensils for poultry farms, A (4) 110.
packing for Gay-Lussac towers, A (4) 111.
pipes, A (4) 110.
thermal balance sheet for firing, A (4) 111.
Stormer viscometer, A (1) 7.
Stove rating, hot-blast, A (6) 163.
Strata, suggestions for the standardization of geological sections of, proved in boreholes, shafts, etc., A (5) 135.
Strontium in Can., occurrence and uses of, A (11) 273.
oxide-soda-silica, glasses, compn., d., refractive index, dispersion, and soly. of, A (4) 112.
Stucco construction, shrinkage of Portland cement mortars and its importance in, A (4) 120.
Sulfate ion in glass, detn. of, A (9) 238.
Sulfide ores, flotation of, in the lab., A (5) 138.
Sulfur in brick, tile, etc., P (1) 17.
on lead glazes, influence of fuels contg., A (10) 255.
Surface combustion, A (5) 140.
combustion and the possibility of its adaptation to the ceram. industry, A (12) 303.
tension app., by drop wt. method, stalagmometer and guttameter, A (10) 248.
app. for rapid meas. of, by drop wt. method, A (10) 248.
detn. of, from rise in capillary tubes, A (8) 204.
influence of, on fusion and solidification, A (1) 7.
20 methods for measuring, anal. of, A (11) 274.
modification of the capillary tube method for the meas. of, A (11) 274.
of colloidal solns., A (11) 274.
Surfaces, chem. reactions on, A (12) 310.
Suspensions, coagulation meas. with, kinetic and static, A (6) 155.
Swedish potteries, recent improvements in, A (3) 71.
Switzerland, manuf. of culinary ware in, A (9) 235.

Talc. in Can., deposits of, A (9) 228.
in New Zealand, occurrences of, A (9) 228.
pottery, magnesite added to body materials of, P (11) 283.
Tanks, heat transfer in, A (3) 73.
Tariff revision and regulation, A (12) 302.
Technical lit., instruction of students in the use of, A (10) 246.
Teeth, artificial, production of, A (10) 255.
porcelain, process of fixing tacks to, P (11) 284.
Telescope disc, Amer. made 40-inch, A (11) 287, A (12) 329.
Temperature automatic control device for elec. fur., P (3) 68.
color, and brightness of various illuminants, A (7) 179.
-control devices for elec. furs., P (4) 109.
exceptionally high, reached with flame, A (2) 41.
high, meas. of, pyrometry, B (1) 6.
high, thermocouple for measuring (W and Mo wires), P (1) 5.
meas. in melting and annealing furs. in the alloy industry, A (5) 133.
Temperatures, high, meas. of vapor press. at, A (3) 60.

high, methods of meas. elec. resist. of insulators at, A (1) 8.
Tensile strength of porcelain, method of detg., A (3) 69.
Terra cotta, brick, causes of disintegration in, A (3) 85.
body cracking of, A (2) 46.
brick, disintegration of, A (2) 46.
cause of fire cracking of, A (3) 85.
Testing materials, American Society for Testing Materials, B (3) 93.
Thermal balance sheet for firing stoneware pipes, A (4) 111.
"balance-sheet" of an annular kiln, A (4) 105.
condy. of glass, effect of alumina on, A (1) 20.
condy. of heat insulators, as cork, slag wool, charcoal, wood fiber, and rubber, A (8) 219.
expansion of quartz, porcelain and some Jena glasses, A (2) 36.
Thermel, suggested term for thermoelec. temp.-measg. devices, A (11) 271.
Thermocouple, Ni-Cr-Cu, P (7) 179.
for high-temp. meas. (W and Mo wires), P (1) 5.
Thermocouples, manuf. of in vacuo, P (4) 99.
Thermo-luminescence in glass, production of, A (12) 328.
Thorpe's soly. ratio of lead frits, A (3) 70.
Tile, black, P (1) 17.
building, and wall made therefrom, P (7) 184.
cement drain, durability of, in alkali soils, A (10) 256.
mach. for making, P (12) 339.
cold glazed, comparison of, with ceram. wall tile, A (8) 211.
concrete, failures in alkali soils, A (11) 284.
roofing, means for use in manuf. of, P (7) 194.
construction, with units of L-shaped cross-section, P (12) 326.
-cutter, automatic, P (7) 185.
cutters, off-bearing mechanism for, P (11) 286.
drain, P (5) 143.
burned with oil and coal, A (11) 276.
method of making, P (11) 286.
report of Comm. C-6, A.S. T. M. on, A (3) 86.
fur. for mfg., P (2) 47.
glass antislip, P (3) 82.
hollow, P (5) 143.
absorption of, A (8) 214.
building, P (11) 286.
building from slag, A (9) 235.
building report of Comm. C-10, A. S. T. M. on, A (3) 87.
building tent. specif. for, A. S. T. M., A (3) 87.
building work of U. S. Bureau of Standards on, A (12) 323.
for floor structures, P (12) 326.
for wall structures, open-end, P (7) 184.
superlocking, P (12) 327.
tent. definitions of terms relating to, A. S. T. M., A (3) 87.
interlocking, P (12) 327.
laying of wall, A (11) 284.
mach. for making ceram., P (12) 322.
properties and tests of, A (2) 46.
roofing, P (5) 143.
vitrified ceram. antislip, P (3) 82.
Tiles, clays for, A (4) 117.
manuf. of, in E. Africa, A (12) 324.
tool for handling, P (7) 185.
Tin, method for detecting, A (12) 310.
Tinware, enamels for, A (6) 167.
Titanium dioxide, fusibility of open-hearth slag contg., A (7) 182.
in bauxite, volumetric detn. of, A (10) 248.
in elec. fur. linings, P (10) 255.
Titration app. with automatically fixed zero point, A (8) 200.
Tower, dry gas-cleaning, P (7) 183.
Towers, stoneware packing for Gay-Lussac, A (4) 111.
Transformation of systems, validity of the principle of Le Chatelier, A (8) 204.
Transition and fusion, reduced temps. of, mathematical anal., A (8) 204.
Translucency of glasses caused by colloidal dispersion, A (11) 289.
of porcelain, A (12) 318.
Transmission factor, meas. of, by use of Ulbricht sphere, A (1) 15.
ultra-violet and visible, of various colored glasses, A (3) 77.
Transvaal, corundum deposits in the Northern and Eastern, A (12) 317.
corundum in the, A (3) 62.
corundum industry in the Northern, A (9) 234.
Trass, addition of, to cements, A (2) 50.
and Portland cement, A (4) 118.
Tremolite asbestos in South Africa, A (12) 306.
Tridymite, atomic grouping and optical rotation of, A (4) 100.
formed during the htg. of silica materials, A (12) 307.
from quartz, influence of subs. on transformation of, A (3) 60.
Tubes, glass, method of, and app. for forming, P (5) 147.
steam gage glass, method of drawing, A (3) 81.
Tubing, glass and cane, drawing of, P (6) 167.
glass, machine-drawing of, A (3) 78.
Tungstates, alkali, prepn. of, P (7) 189.
Tungsten hydroxide sols., prepn. of, with help of the Hildebrand cell, A (8) 202.
pyrometer filaments, current-temp. relation for carbon and, A (4) 98.
trioxide, note on the green color of, A (7) 180.
Tungstic acid, effect of, on gelatinization of silicic acid in strong hydrochloric acid soln., A (8) 203.
Tunnel kiln, P (7) 183.
an oil gas compensating, A (11) 277.
car, Faugeron, A (3) 70.
See Kiln, continuous.
with sectional combustion-chambers, P (1) 11.
Tunnel kilns in Japan, A (11) 277.
modern, as Buch, Möller, and Pfeifer, and Dressler systems, A (9) 225.
Tunnel oven. See Kiln, continuous.
Turbo pulverizer, for powdered fuel, A (6) 156.
Tyndallmeter for approx. detn. of conc. of colloids in a clay, A (3) 60.

Uehling carbon dioxide recorder, A (1) 5.
Ultramarine pigments, A (2) 37.
Ultra-violet absorption by glass, contg. CeO_2 and MnO_2, P (10) 260.
absorption of glasses, effect of temp. upon, A (6) 165, A (7) 187.
coloration of glass, A (12) 331.
rays on glass, effect of, A (10) 259, A (12) 328.
transmission of various colored glasses, A (3) 77.
Union gas calorimeter, A (11) 271.
United States, alunite deposits in, A (9) 233.
manuf. of window, plate, wire, and sheet glass in, A (3) 72.
Utensils, clay or stoneware, for poultry farms, A (4) 110.
stoneware cooking, A (4) 110.

Vacuum filtration, app. for, P (6) 160.
high, high speed, mercury vapor pumps, A (8) 200.
Valence scale of metals by means of water vapor equil. and the dissociation press. of their oxides, A (4) 103.
Valve, gas and air, new Bergman, A (3) 80.
Vanadiferous asphaltites of Central Peru, A (9) 233.
Vapor press. of some salts, A (6) 160.
pressures, meas. of, at high temps., A (3) 60.
of alkali halides, A (3) 60.
of SiO_2, Al_2O_3, CaO and MgO, A (1) 9.
Vials, automatic necking and bottoming mach. for, A (7) 187.

Viscometer, Hadfield-Bawtree, A (1) 7.
Stormer, A (1) 7.
torsion, Doolittle, A (1) 6.
torsion, MacMichael, A (1) 6.
Viscosimeter, P (7) 179.
air-bubble calibration, A (10) 246.
Viscosimeters, description of 8 types of, A (2) 33.
for highly viscous mat., P (6) 159.
use of commercial, A (12) 306.
Viscosity, absolute, meas. of, A (8) 198.
meas. by Cochius air bubble method, A (4) 99.
of glass, effect of alumina on, A (1) 20.
of molten glass by X-ray photographs of a falling sphere, suggested method for detg., A (12) 328.
of oils at high pressure, A (2) 31.
Viscous deformation, study of elastic, A (3) 64.
Vogelsberges, bauxite deposit of, A (5) 138.

Wad clay, proper use of, A (1) 12.
Water-gas. See Gas, water-.
resistant compn., cold production of, A (10) 245.
Waterproofing cement, P (3) 93.
compn. for cement, P (5) 150.
Weathering of glasses, barium oxide-potassium oxide-silica, A (6) 165.
barium oxide-soda and potash-silica, A (6) 166.
barium oxide-soda-silica, A (6) 165.
potash-lime-silica, soda-lime-silica, potash-lead oxide-silica, soda-lead oxide-silica, A (1) 20.
Weathering of optical glass, methods of detg., A (12) 329.
Weatherproofing clay by calcium silicate pptn., P (12) 305.
Weighing by substitution, A (9) 230.
mechanism for small loads, A (11) 270.
Weldability of solid powders by press., A (4) 99.
Westerwald "Osmo" clay, A (4) 97.
Wetting, heat of, of silicic acid, A (5) 135.
Whiteware bodies, factory prepn. and burning of, A (12) 320.
bodies, use of stains in, A (12) 321.
glaze defects and their prevention, A (1) 14.
industry, grinding and prepn. of raw materials in, A (9) 235.
potteries in Spain and Portugal, A (3) 70.
Wood, firing temps. attainable with, A (4) 108.
-Harry cleaner and ore concentrator, A (10) 246.
Works management in a cement factory, A (4) 118.

X-ray detn. of crystal arrangement, A (11) 271
X-ray diffraction app. for powders, new, A (8) 200.
on glass, effect of, A (10) 259, A (12) 328.
tests for stone, A (10) 244.

Zeolites, chem. constitution of, A (12) 310.
Zinc borate, prepn. of, A (8) 202.
ores, retorts for, A (8) 208.
oxide, prepn. of, P (5) 139, P (6) 162, P (9) 225, P (10) 251.
-soda-silica glasses, compn., d., refractive index, dispersion and soly. of, A (4) 112.
-smelting fur., P (5) 142.
titration of, A (12) 310.
volumetric and gravimetric detn. of, A (8) 205.
volumetric and gravimetric methods for detn. of, A (7) 174.
Zircon and clay refrac. compn. for retorts, etc., P (10) 255.
Zirconia, method of chem. anal., A (7) 181.
prepn. of, A (4) 104.
prepn. of from Brazilian ore, A (7) 181.
production and testing of, A (8) 198.
refrac. material of mixt. of alumina and, P (4) 108.
Zirconium and its compounds, B (6) 172.
and zirconium oxide, occurrence, properties and uses of, A (8) 209.
fluoride glazes for porous pot ware or iron ware, A (11) 281.
new uses for, A (11) 275.
oxide and metal, investigation of, A (3) 67.
and steatite used as a refrac. compn., P (11) 280.
and zirconium, occurrence, properties and uses of, A (8) 209.
in sagger bodies, A (12) 321.
refractory bodies for temps. over 2000° in furs. with reducing atmospheres, A (9) 233.
oxychloride and zirconium oxide sols, physico-chem. anal. of, A (4) 104.
silicate and Al silicate, with carborundum as a refrac. material, P (3) 68.
Zircon spark plug porcelain, A (12) 321.
with clay binder as refrac. compn., P (3) 68.
Zirkite, elec. fur. purification of, A (3) 67.
$ZnSiO_3$, m. p., sp. gr., and refractive indices of, A (3) 63.
Zn_2SiO_4, m. p., and refractive indices of, A (3) 63.
$ZrSiO_4$ in elec. porcelain, use of, A (1) 14.
$ZrSiO_4$–Li_4SiO_4, the system, A (1) 6, A (3) 61.

ABBREVIATIONS USED IN INDEX

abs.	absolute
a. c.	alternating current
alk.	alkaline
amt.	amount
anal.	analysis
app.	apparatus
approx.	approximate, approximately
at. wt.	atomic weight
av.	average
b. p.	boiling point
B. t. u.	British thermal units
bldg.	building
Brit.	British
cal.	calory(ies)
calc.	calculate
calcd.	calculated
calcg.	calculating
calcn.	calculation
Can.	Canada
cc.	cubic centimeters
ceram.	ceramics
charac.	characteristics
chem.	chemical (not chemistry)
cm.	centimeter(s)
circ.	circular
Co.	Company
Comm.	Committee
coeff.	coefficient
compd.	compound
compn.	composition
concd.	concentrated
concn.	concentration
condy.	conductivity
const.	constant
contd.	contained
contg.	containing
c. p.	chemically pure
cryst.	crystalline (not crystallize)
crystd.	crystallized
cu. m.	cubic meter(s)
d.	density
d. c.	direct current
decompn.	decomposition
det.	determine
detd.	determined
detg.	determining
detn.	determination
dil.	dilute
econ.	economical
ed.	educational
elec.	electric, electrical
e. m. f.	electromotive force
equil.	equilibrium
equiv.	equivalent
est.	estimate
estd.	estimated
estg.	estimating
estn.	estimation
evap.	evaporate
evapd.	evaporated
evapg.	evaporating
evapn.	evaporation
examd.	examined
examg.	examining
examn.	examination
expt.	experiment
exptl.	experimental
ext.	extract
extd.	extracted
extg.	extracting
extn.	extraction
f. p.	freezing point
ft.	foot, feet
fund.	fundamental
fur.	furnace
gen.	general
g.	gram(s)
htg.	heating
h. p.	horsepower
hr.	hour
in.	inch(es)
indus.	industrial
inorg.	inorganic
insol.	insoluble
invest.	investigation
kg.	kilogram(s)
kw.	kilowatt(s)
l.	liter(s)
lab.	laboratory
lb.	pound(s)
lit.	literature

mach.	machinery, machine
mat.	material
m.	meter(s)
manuf.	manufacture
max.	maximum
mfg.	manufacturing
meas.	measure, measurement
mech.	mechanical
mg.	milligram
min.	minute(s)
mixt.	mixture
mol.	molecule, molecular
mol. wt.	molecular weight
m. p.	melting point
N	normal
org.	organic
operg.	operating
opern.	operation
oper.	operate
p. d.	potential difference
phys.	physical
physiol.	physiological
Port.	Portland
powd.	powdered
prac.	practical
ppt.	precipitate
pptd.	precipitated
pptg.	precipitating
pptn.	precipitation
press.	pressure
prep.	prepare
prepd.	prepared
prepg.	preparing
prepn.	preparation
prob.	problem
qual.	qualitative
quant.	quantitative
ref.	reference
refrac.	refractory
rept.	report
resist.	resistance
resis.	resisting
resp.	respectively
r. p. m.	revolutions per minute
sat.	saturate
satd.	saturated
satg.	saturating
satn.	saturation
sec.	second(s)
scien.	scientifically, scientific
sep.	separate
sepd.	separated
sepg.	separating
sepn.	separation
sol.	soluble
soln.	solution
soly.	solubility
sp.	specific
sp. gr.	specific gravity
sq. cm.	square centimeter(s)
specif.	specifications
stand.	standard
subs.	substance
temp.	temperature
tent.	tentative
v.	volt(s)
vol.	volume (not volatile)
wt.	weight

Ceramic Abstracts

Compiled by the

American Ceramic Society

Ross C. Purdy, *Editor*
Emily C. Van Schoick, *Assistant Editor*

Volume 1, 1922

Abstractors: E. N. Bunting, W. M. Clark, L. H. Cole, James L. Crawford, R. R. Danielson, G. S. Fulcher, S. L. Galpin, R. F. Geller, James Hepplewhite, H. P. Hood, R. M. Howe, Seiji Kondo, A. T. Malm, R. J. Montgomery, Louis Navias, C. W. Parmelee, C. M. Saeger, Jr., H. G. Schurecht, R. B. Sosman, H. F. Staley, E. W. Tillotson, F. A. Whitaker.

BULLETIN
of the
American Ceramic Society

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical and Scientific Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

F. H. Rhead, M. C. Farren } Art
B. T. Sweely, R. R. Danielson } Enamel
J. C. Hostetter, A. E. Williams } Glass
J. S. McDowell, F. A. Harvey } Refractories
F. K. Pence, C. C. Treischel } White Wares
A. F. Hottinger, R. L. Clare } Terra Cotta
C. F. Tefft, M. B. Greenough } Heavy Clay Products

OFFICERS OF THE SOCIETY

Frank H. Riddle, President
Champion Porcelain Co., Detroit, Mich.
E. Ward Tillotson, Vice-President
Mellon Institute, Pittsburgh, Pa.
Ralph K. Hursh, Treasurer
University of Illinois, Urbana, Illinois
Ross C. Purdy, General Secretary
Norah W. Binns, Assistant Secretary
Emily C. Van Schoick, Assistant Editor
Lord Hall, O. S. U., Columbus, O.

TRUSTEES

Roy H. Minton
General Ceramics Co., Metuchen, N. J.
Forrest K. Pence
Knowles, Taylor & Knowles, E. Liverpool, O.
Fred B. Ortman
Tropico Potteries Co., Glendale, Cal.
Raymond M. Howe
Mellon Institute, Pittsburgh, Pa.
B. E. Salisbury
Onondaga Pottery Co., Syracuse, N. Y.

Vol. 1 December, 1922 No. 12

EDITORIAL

INDIVIDUALISM vs. COÖPERATION

The time is within the memories of many living when man was very much more dependent on hand labor in all things, and when traveling, even across town, was tedious and news was carried mostly by couriers. Under these circumstances there was very little of collective labor and practically no industrial coöperation. In comparison with the present there was, one or two generations ago, very little mutual dependency of man industrially. But with the possibilities and necessities of men working in organized groups brought about by machinery and process inventions, men became more and more dependent upon their fellows.

The affairs of man are becoming more complex with each passing year making more pronounced this mutual dependency. This is reflected in the many and increasing numbers of commissions appointed to adjust affairs between capital and labor. The prosperities and adversities of one state in the Union are shared by all to an increasing degree with each passing year. The prosperities and adversities of the "Far East," of Russia and of all lands are reflected in the affairs of this country to a greater and greater extent each succeeding year. Mutual dependency is becoming more evident.

Displacement of hand labor by machine methods has brought the industries from the home shops into factories and the more rapid and dependable means of communication have caused the individual factories to combine into still larger industrial groups. The side hill coke ovens

and lime kilns of individual farmers are now rarities if not wholly extinct and the small hand brick yard is an economic impossibility. In spite of our natural aversion to the "wicked combines" and to the "large financial interests," these must be recognized as legitimate products of the increasing complex industrial conditions. They are the inevitable results of big machinery and improved methods giving larger production.

Trade and technical associations, industrial research laboratories, federal bureaus, semi-public research institutes, research councils of each industrial nation and the more recent international councils are not fads but are the natural means suggested by the increased complexity of industrial affairs which in turn calls for organized coöperation.

The consequences of attempts to eradicate "trusts" and "big financial interests" by resolving the industries back to the state of individualism are to be seen in Russia. Communism that involves the dissolution of stock companies, big or little, has always resulted in demoralization. Coöperation of concerns through Associations is the only communism that will meet the requirements brought about by the modern equipment and methods for manufacturing and transportation.

Continued industrial prosperity will require either larger "combines" and more of them or more intimate coöperation through associations. Failure to support these associations is a failure to provide the means of manufacturing by concerns of relatively small capitalization.

The American Ceramic Society gives the opportunity for organized coöperation of ceramic industries to promote their technical, scientific and artistic welfare. Next February in Pittsburgh recognition will be given to the foresightedness of that group of twenty-one pioneers, who, under the leadership of Professor Edward Orton, Jr., twenty-five years ago organized this ceramic technical and scientific Society.

Ceramic industries are coöperating in technical and scientific research much more today than heretofore but there is yet a great deal of harmful prejudice against the sharing of information. The ceramic industries have not yet reached the stage where several concerns will pool their scientific knowledge of materials, mixtures and processes as do some of the concerns in other industries.

It is the policy of this Society to preach and to practice coöperation in things technical, scientific and artistic. When the conventions of trade associations and associations of users of ceramic products, and when the trade papers and journals are filled with reports of researches on ceramic problems, this Society will have realized the ideal. It is to this end that we are working.

Individualism in industrial, scientific and artistic ceramics is essential but to a larger degree today than at any time past there is need for more intimate coöperation.

DISCUSSION[1] ON "BEST TYPE OF CROWNS TO BE USED OVER GLASS TANKS"

MR. KNOTHE:—There is apparently no certain answer or solution at present to the question of the best type of crowns to be used over glass tanks. The suggestion of using a flat crown under the furnace has been made several times. Often the opinion has been advanced that a tank furnace is too large a unit for that type of construction to be feasible. From a mechanical standpoint it is entirely practicable to build a flat crown on a furnace.

MR. HOSTETTER, CHAIRMAN:—You have had experience or some suggestions along that line?

MR. KNOTHE:—We have worked up a design for that type of furnace. It has not been tried out yet, and I am not in a position to say what can be expected but it is believed that the furnace can be built and made practical from a mechanical point of view.

MR. CRUIKSHANK:—The Murphy Iron Works have used the flat type of arch in the furnaces under boilers. They use rectangular blocks provided with tee-headed slots in their upper surface by means of which they can be suspended by bolts to beams running across the furnace. The design is patented by them. The device has been very successfully used in boiler furnaces as it confines the heat as well as brings the top of the furnaces closer to the boiler tubes and thus economizes space. Another decided advantage is the facility for renewing anyone of the blocks. The only difficulty I can see in the use of such a cover over melting furnaces is that there would be a tendency for the joints to open, whereas with the ordinary arch held by buckstaves the brick are held tight together and there is no possibility of leakage of gases through the crown. With the suspended flat blocks the arch effect is done away with.

THE CHAIRMAN:—The flat arch would have one advantage, that of a smaller surface to radiate. What other advantages would you suggest that it would have?

MR. KNOTHE:—A flat arch could be repaired in spots without disturbing any of the rest of the arch.

DISCUSSION[2] ON "ABSTRACTING AND PUBLISHING DATA OF VALUE FOR GLASS-RESEARCH LABORATORIES"

MR. HOSTETTER:—This subject is listed in the program as "Possibilities of Having Records of Each Industrial Glass-Research Laboratory Systematically Examined with View to Abstracting Data of Value and Publishing the Same." The National Research Council is collecting data of that type wherever possible to secure it and we have had requests from

[1] Glass Division, St. Louis Meeting, Feb. 1922.

[2] Glass Division, St. Louis Meeting, Feb., 1922.

the Council along this line. It is a question of getting time to dig through the files and get it out for them. I think it is a desirable thing that if we can get fundamental data from the research laboratories dealing with these questions, to get that material in form available for the industry. Probably those of you in laboratories from glass houses around the country have had similar requests from the National Research Council. In connection with research in glass I would like to call your attention to a report in the Year Book of the American Ceramic Society, in which the Committee on Coöperative Research, Glass Division of the American Ceramic Society, in the National Research Council, have proposed subjects for research on Glass Technology proper: (1) *Physical Properties of Glass:* Viscosity of molten glass, especially factory methods for determination; surface tension of molten glass, especially factory methods for determination; density of molten glass, especially factory methods for determination; (2) *Chemical Studies on Glass:* Correlation of physical properties with composition; reactions taking place in glass manufacture, with especial reference to the rate of evolution of gas; gases dissolved in glass; effect of temperature and duration of fining; effect of chemical composition; development of colored glasses; manufacturing problems; correlation of fining temperatures with physical properties; study of methods of furnace control, such as devices for measurement of temperature, of velocity of gas, air rate and completeness of combustion; (3) *Problems of Furnace Construction (Refractories):* improved material for tank walls; effect of special cements and coatings on furnace and tank life and efficiency; furnace and tank design.

This is submitted without much comment, and it would be helpful indeed if we could get laboratories equipped for doing this work such as the Bureau of Standards and Mellon Institute to set about this in a systematic manner, and get at some of these problems. If other companies were to establish industrial fellowships as Corning Glass Works has with Doctor Washburn at a cost of a thousand dollars per annum, half-time service, they would soon make fast strides in really knowing why and how to do certain things.

DISCUSSION ON "WHY ARE OPEN POTS USED IN EUROPE AND NOT IN THE U. S.?"[1]

MR. HOSTETTER, CHAIRMAN:—The question of "Why Are Open Pots Used in Europe and not in the United States?" My impression was that we use in this country both open and closed pots. Yesterday Mr. Bellamy cited literature to the effect that it was impracticable to lay glass in contact with flames in open pots. When we started to make optical glass in this country we were very much worried about making dense

[1] Glass Division, St. Louis Meeting, Feb., 1922.

flint glass in open pots. We finally got up to lead glass, 55% lead oxide in open pots, and in the course of melting hundreds of pots of glass, containing about 45% oxide I have never seen indications due to the reduction of lead. Occasionally a water cooler would break and get some metal in the pot such as a chunk of iron, but no discoloration as far as we could work out took place from the reduction of lead by the flames. Has anyone experience along similar lines?

MR. WRIGHT:—I have talked to a few glass-makers who came from foreign countries, and they have often spoken of open pots in the furnaces, where they fill in the pots and melt over night, and the following day cool down the furnace and work from those pots. They were making a periodic operation either every day or every other day from these furnaces. In this country most of the glass furnaces maintain a melting heat all the time so that when the glass pot is filled in and finally melted the pot glass can be moved by removing the stopper without reducing the temperature of the melting unit.

MR. FORSYTH:—I would like to have you ask Dr. Hess what he knows on the subject, especially about the practice in Holland in melting in these open pots.

DR. HESS:—England, Holland and Germany use small open pots on lead glass. The matter of open pots for lead glass depends very much on the size of the pot and the area. It is perfectly feasible to melt lead glass in open pots with absolute success. In optical glass, for instance, up to a definite size you have found that that could be done; and in the early days on the bulb machines we were trying to work tanks on lead glass. We had some very interesting and peculiar results. Quite frequently we would get a very good glass. We were working by hand at that time the same as if we were working in the pots now and sometimes we would get a run of beautiful glass for an hour or two. Often, however, for a half-day, a half-month or a month we would not get glass that was clear. The greatest trouble there seemed to be the flowing of the different densities of glass over the surface of the tank. The glass of a lighter specific gravity would flow over the top, and it would pull with it the heavier glass from the bottom. It might be that a device inserted into the tank for stirring might help matters. We have done some experimental work along these lines and found we could handle it, but it has not been wholly satisfactory. In relation to the open pots, it is a question of a different system of working. They work at one time and melt at another; they make their melt over night, and work in the daytime. But they work much smaller pots than we do and they find it impossible to work and melt at the same time. There is no question but that a great deal of work can be done on the closed pots if proper conditions of flame and temperature are developed. You have to be exceptionally careful and not have a tem-

perature raise while working lead glass. A temperature raise always gives trouble. You have all heard that you could not make ruby glass in tanks, but that is an exploded theory. I have also seen people make ruby glass in pots and seal the pot so thoroughly that it has blown the crown off by reason of the accumulated gas pressure. I do not think there is any difficulty in making ruby glass in tanks or lead glass in open pots but when you come to a certain size definite mechanical features must be introduced.

THE CHAIRMAN:—Are these gold rubies or selenium rubies?

DR. HESS:—Both gold and selenium rubies.

MR. WRIGHT:—I would like to raise a question here on ruby glass. Dr. Hess made a statement about causing the gas to press out through the crown. Was that the pressure of gases?

DR. HESS:—That was a case of there being no escape for the gas. It was simply a condition developed on the part of the caretaker of the furnace.

MR. WRIGHT:—Do they not retain a certain quantity of those gases which are lost in the tank?

DR. HESS:—I produced the same color from the same batch in both tank and closed pot. Faster melting seemed to give me better results from the slower melting.

THE CHAIRMAN:—Mr. Bellamy, what rubies did you melt in that small tank?

MR. BELLAMY:—Gold rubies only.

MR. HOSTETTER:—I do not know of any furnace in existence in this country of the circular type in which open pots are used. Does anyone know of any European styles that are in existence in this country? It may be that investigation will show there is a real economy in getting quicker melts and lowering them the next day. Certainly with the open pot you secure much more rapid melting than in the covered pot.

DR. HESS:—I think in a great many cases they have not used an open pot entirely. A removable cover was used such as we had in the crown of the pot. This was removed to facilitate the melting and during working time closed up, so that the flame would not blow in on the surface of the glass. This is necessary when working and melting at the same time.

MR. HOSTETTER:—I have used those. They work out all right.

MR. FORSYTH:—In talking with some men from Holland who operated the open pot, they brought up the point that in working out these open pots, it was very much hotter than working out of the closed pots; and that our workmen might perhaps raise some objection on that point.

MR. HOSTETTER:—No doubt they would in this country.

MR. GRAFTON:—The only place that I know where they work the open pots in colored glass is in the Johnson Glass Company of Hartford

City, Indiana. They have a small furnace containing four pots, a burner in the center radiating heat, and flues in each corner of the furnace built on the style of a pot arch. I cannot give you very much information in regard to the furnace but anyone interested in the subject, could write to George Fulton of Hartford City, Indiana. I am sure he will give you the information you desire regarding the melting in open pots.

DISCUSSION[1] ON "GLASS CONTAINERS"[2]

MR. WILLIAMS:—The Glass Containers' Association has started a Fellowship at the Bureau of Standards and we have one man working. I have given a great deal of time and attention to that work myself. The problem which we thought would be the most interesting to the greatest number of the glass manufacturers was some scheme for preventing the weathering or scumming on the ware in storage, which causes considerable loss to everyone. We are also working on the properties of glass with respect to use for food-packing and canning, to be used in place of the tin can containers. It is desirable to get a method and apparatus more suitable to the physical properties of glass.

MR. HOSTETTER:—Mr. Williams evidently has been dealing with some glasses that are very unstable. I think all of us have had experience at times with glass and know the troubles we have had with them before we could ship them to our customers. The stability of glass is a very important field for investigation. Aside from this, however, there are many problems involved in the manufacture and use of glass containers, for instance, the packing of carbonate water. We have there the possible action by CO_2. Dr. Bitting has told me that ginger ale was packed in glass and shipped to distributing points. The breakage in transportation to the distributing points was very small. After six weeks' storage the breakage had increased greatly as compared with the first breakage, due presumably to the fact that the glass was subjected to fatigue, having, been exposed for this period of time to high internal pressure of carbon dioxide. The work of the Containers' Association of which Dr. Bitting is Director of Research is extremely important and this Division should certainly work in close coöperation with them wherever possible.

The question of the strength of glass stability in contact with foods of various kinds, as well as the weathering in the air are matters to be considered.

Mr. Williams showed pictures[3] of some milk bottles that were weathered

[1] Glass Division, St. Louis Meeting, Feb., 1922.

[2] Bitting, *Jour. Amer. Ceram. Soc.*, **5**, 85 (1922); Ford, *ibid.*, **5**, 837 (1922).

[3] See Williams, "Disintegration of Soda Lime Glasses in Water," *ibid.*, **5**, 504 (1922).

very badly. The statement was made that the average life of a milk bottle was something like five trips.

MR. FORSYTH:—Three.

MR. HOSTETTER:—Mr. Forsyth says it is three trips but five is the lowest number I had been informed of.

MR. WILLIAMS:—The National Dairymen's Association, as far as they have gone, show that the life of a milk bottle is thirty days.

MR. FORSYTH:—My only information was the statement made during the milk controversy in Cleveland by one of the largest milk concerns there. It might have been a little advertising policy. I asked one dairyman about it. It is only one case and not an average case. He said they averaged eight trips.

MR. HOSTETTER:—It is surprisingly low, whether it is three or eight. We certainly ought to develop glass that would stand up a longer period than that.

MR. WILLIAMS:—You cannot blame that all on rough handling of the dealer and the user; sterilization of the bottles and sudden heating in the winter time affect the life of the bottle. I have been in dairies where they were washing bottles and noticed incipient cracks, very small and hardly noticeable when the bottles are cold. Those bottles are naturally weakened and the second time they are washed the crush grows a little more although the final break may come in handling. Milk bottles are very strong and will stand quite a blow when they are new, but glass seems to suffer from fatigue as much as metal and the breakdown is not altogether due to the rough handling.

MR. YUNG:—The glass companies have quite a job on their hands if they are going to combat the work of the Glass Container people themselves, for they are having quite a campaign now. Every paper that comes out fosters the use of glass containers. Not long ago, I read a paper where they advised the glass people to smash all the bottles they could get their hands on. They went so far as to advise all their traveling men and anybody connected with the industry to ask in the hotels for all the condiments, such as catsup, in bottles so as to create a greater amount of breakage, by having them handled oftener. It seems to me we should have something to make the bottle stand up, if they are working another combination for destruction.

MR. HOSTETTER:—Has anybody any knowledge as to the relation between "weathering" and "strain" in the glass? Is strained glass more subject to corrosion than glass properly annealed.

MR. YUNG:—Some work done on case-hardening may help on that. The straining of the glass showed something to the effect that the glass container or dish which was case-hardened was less attacked than one which was annealed and the weathering that was shown was by the cutting

of the external surface. A case-hardened piece of glass has a surface under intense compression, and it seems that that compressed surface is more resistant to corrosion than that with a cut or broken surface underneath.

MR. HOSTETTER:—Would you go so far as to say that if you had a surface in tension it would be attacked more rapidly than one in compression? Would you say that there was any degree of strain, positive or negative?

MR. YUNG:—I do not know that it necessarily was a compression of the surface. The experiments were not carried out far enough.

MR. HOSTETTER:—The plate glass people, for instance, maintain that their glass as cast is more resisting than after it has been ground and polished.

MR. FULTON:—I think they are right in that.

MR. BROWN:—I can state positively that glass which has been ground after it has been cast has nothing like the resistance to weathering like glass as cast.

MR. WILLIAMS:—In our numerous tests by treating glass in boiling water or in an autoclave the original glass surface is always more resistant to corrosion than merely fractured edges or ground surfaces. Whether these surfaces are in compression or tension, I do not know, but I do believe that they are in equilibrium with the interior.

MR. GOODMAN:—I should like to know if anyone has any formation on the subject of the weathering of glass. In opening up some large glasses that were packed in cartons, there were corrugations formed, a white film on the glass. Is there anything on the cardboard that would cause that to be affected with these corrugations?

MR. PAYNE:—We have noticed this several times and have found it was just from the warehouse, or coming from the paper, but we are not familiar with the actual markings of weathering where the ware was in contact with paper.

MR. WILLIAMS:—Was that the marking on the exterior of the bottle or interior?

MR. GOODMAN:—The entire glass had a white film and could be seen along where the bottle and the article touched the corrugations. You could see the corrugated marks.

MR. WILLIAMS:—It is very rare indeed to see scumming on the exterior of a container. It is always on the interior where the evaporation goes on much slower. That is the reason for it. Those corrugations might have been dust and dirt. Did you try to wash them off?

MR. GOODMAN:—Yes.

MR. WILLIAMS:—Then it was probably the weathering.

MR. GOODMAN:—We have noticed that in taking some articles and putting them outside of the cardboard cartons, nothing happens to them, but

when we place them in the carton and leave them there a while we see the corrugation marks on the glass.

MR. BROWN:—The question of weathering bottles resolves itself into one similar to any other kind of a question of glass: that is the question of moisture. CO_2 moisture apparently has no effect, and in these bottles, I have seen a case where the ridge itself absorbed the moisture.

MR. WILLIAMS:—When you make a survey of the weathering proposition, you will find all types of soda lime glass from the highest to the lowest, affected with the phenomena of scumming in storage. Therefore, in trying to find the method of obviating the occurrence of this it looks as though it might be a proposition of trying to avoid scumming by getting the right method of storage rather than correcting the composition since we have it in plate glass and window glass, and also in all types of bottles. Consequently, it may occur in glasses having a wide variety in composition under certain conditions of storage.

MR. HOSTETTER:—Unfortunately we cannot always have the storage facilities desired. I am reminded of the remark of Mr. Dixon in regard to the stability of glass when salt cake is used in the batch. Glass of the crown type can retain in solution considerable proportions of both chloride and sulphate, and perhaps the presence of the sulphate acts as a stabilizer to some extent.

There is an interesting thing in connection with weathering that occurs in glass used in lampworking. Glass that has stood around for many years will have a weathered film over the surface. When this glass is heated in a blow-pipe flame it cracks very readily. There are two means of avoiding this difficulty: One is to dry, wash off the weathered film on the glass with hydrofluoric acid and the second is to introduce sodium vapor into the flame which in turn will act on this surface film and restore it to the original condition.

MR. BROWN:—Does that idea hold as well on boricsilicate as sodium lime?

MR. HOSTETTER:—I can't tell you that. Mr. Forsyth says to some extent it will work.

DISCUSSION ON "FINE OR COARSE-GROUND MIXTURES FOR CHECKER BRICK IN GLASS FURNACES"[1]

MR. ZOPFI:—I know nothing about this subject from practical experience, but it occurred to me that there might have been some of the members who have conducted an investigation along these lines, on whether fine ground checker brick, due to its structure will absorb and give off heat more rapidly than a coarse-ground brick.

[1] Glass Division, St. Louis Meeting, Feb., 1922.

MR. HOSTETTER:—The spacing of bricks in checkers is highly important. It has not been given sufficient consideration in furnace design. Heat transfusion is a function of the velocity of the gas and that in turn depends upon the spacing of the checkers and the pressure under which the furnace is operated. That end of it has received some consideration, but the question of the texture of the actual brick in the checkers is before us now.

MR. ZOPFI:—The impression I had in reference to checker brick has been that a great many glass manufacturers insist that the checker brick be a very coarse-ground mixture with the idea that heat will penetrate very much more rapidly and give off more rapidly than will the fine-ground brick. We are inclined to question this, though we have had no actual demonstration in a glass house checker. A glass melting pot of fine texture will melt quicker than one of coarse grain and for that reason we believe that the checker brick of fine-grain clay mix is better than the coarse grain.

A MEMBER:—Is there any differentiation between the density due to vitrification and density due to finer-grained mixtures, *i. e.*, is the dense texture which you have in mind due to the mixture of grog and clay, or to the degree of vitrification or to both?

MR. ZOPFI:—I would say that the density was due to both the degree of vitrification and size of grog, but the density or structure due to amount and size of grog would be the most important.

MR. FULTON:—I have no knowledge of any tests covering the subject brought up by Mr. Zopfi, but it has been the general practice to use coarse-grained brick for checkers. The reason held for this is that a coarse open texture brick will withstand repeated heating and cooling and will have less tendency to spall than a brick of fine dense texture.

MR. HOSTETTER:—That is true unless they were made out of zirconium silicate.

MR. BROWN:—That has been my experience too.

MR. FORSYTH:—It looks to me as if there has been no actual demonstration of the fact that the dense brick would spall under those conditions. After old checker brick are well glazed and rendered fairly dense we have noticed spalling.

MR. FULTON:—I know of one experiment where silica brick was used for the top courses of the checkers in an effort to prevent the collection of dust at this location. In this respect the experiment was a success but the fluxes carried into the checkers attacked the silica brick very rapidly and after a very short period more than half of each brick was washed away. While silica brick has a strong tendency to spall, these brick when removed showed a dense glazed surface and there was no evidence of spalling.

DISCUSSION ON "THE INFLUENCE OF HEAT ON THE MICROSCOPIC PROPERTIES OF SILICA IN ITS DIFFERENT MINERAL FORMS"[1]

By Herbert Insley:—Mr. Robson's article is apparently based on the assumption that there is a gradual change from one polymorphic modification of SiO_2 to another, *i. e.*, that the physical properties of quartz change gradually when it inverts to tridymite or cristobalite and that the process of inversion can be stopped at an intermediate point and there the physical properties such as index of refraction will be found intermediate between those of the two crystalline modifications. Such a conception of the mechanics of polymorphic change is contrary, as far as I know, to any modern theories.

Table II in Mr. Robson's article gives the index of refraction of quartz as 1.545 before heating and as 1.517 after heating to cone 14. The author explains this change in the following sentence: "No effect is noticed in the case of either sand or quartz on the index at cone 13, about 1390°C, but at cone 14, about 1410°C, a decided drop has taken place in the indices of both substances, showing that above cone 13 both sand and quartz tend to transform into cristobalite, which has an index of refraction of 1.487." The above statement seems to imply that 1.517 is the index of refraction of a pure homogeneous crystalline modification of SiO_2 with physical properties between those of quartz and cristobalite.

Unfortunately the methods of examination were not given in detail, but it seems probable that the particles examined microscopically after heating to determine the index of refraction were not homogeneous but were intimate mixtures of quartz and cristobalite which gave values for the index of refraction somewhere between the true values of quartz and cristobalite. If this is the case it is dangerous to base estimates of the percentage of the whole sample inverted to cristobalite on the index of refraction of single aggregates which very probably are not representative of the sample.

The conclusion reached by the author, "that French flint and chalcedony both transform into cristobalite before sand and quartz," may be true but the article under discussion does not prove it for the conception of the mechanics of crystalline transformation on which the conclusion is based is not the generally accepted one and has not been proved.

Mineral Forms

By Mr. Robson:—In answer to Mr. Insley's discussion the writer wishes to state that he is of the opinion that there is a gradual change in the aggregate from one polymorphic modification of SiO_2 to another.

[1] J. T. Robson, *Jour. Amer. Ceram. Soc.*, **5**, 670 (1922).

Of course there is not a gradual change from one form to another in the discrete particles of the aggregate, as is well known, but all the discrete particles do not transform at the same time and hence the aggregate mass which is what is seen under the microscope will be made up of changed and unchanged discrete particles which altogether will give this aggregate an intermediate index of refraction such as claimed by the author. This phenomena of gradual polymorphic transformation of the aggregate is shown by Spotts McDowell[1] where he gives a table showing the effect of repeated burning upon the constitution of silica brick. A portion of this table illustrating this gradual change follows:

Mineral	Number of burns 1 Volume per cent	3
Quartz (and silicates)	25	12
Cristobalite	71	58
Tridymite	4	30

Note the decrease in the volume of quartz after the third burn, likewise the variation in volume of cristobalite and tridymite.

In our laboratory we have a sample of sand which has gone through the glost kiln of a tile plant. When immersed in oil of 1.545 index (that of quartz) this sample has high relief, when immersed in any other oil as 1.487 index (that of cristobalite) the grains still have high relief. This is explained by the fact that a thin skin or shell of cristobalite has formed on the outside of the quartz and when immersed in oil of 1.545 index the cristobalite shows then and *vice versa*, when placed in oil of 1.487 index, the quartz causes a high relief in the oil so that the cristobalite cannot be determined.

However, when these grains are crushed in a mortar, the cristobalite shell index and quartz index can be determined readily.

In reply to Mr. Insley's statement, "It is dangerous to lose estimates of the percentage of the whole sample inverted to cristobalite on the index of refraction of single aggregates which very probably are not representative of the sample," I would call attention to the statement by Posnjok and Merwin.

By calculating as nearly as possible the volumes of the various impurities and assuming the additive relations for refractive index, the calculated mean refractive indices for several analyzed specimens have been found. Comparison of them with the observed values is found in Table IV.

In view of the above prescribed mode of precedure by these authorities, the writer feels absolutely justified in drawing the conclusions to which Mr. Insley objects.

[1] "A Study of Silica Refractories," *Trans. Amer. Inst. Mining Eng.*, **57**, 43 (1918).

TABLE IV

No.	Mean refractive index, calculated from analyses	Mean refractive index, measured
9	2.28_6	2.30
10	2.27_2	2.28
13	2.22_5	2.21
14	2.22_3	2.19
15	2.20_2	2.19
16	2.17_8	2.17
17	2.16_8	2.17
18	2.11_7	2.12

The writer wishes to make it clear that he does not claim that there is a pure homogeneous crystalline modification of silica with physical properties between those of quartz and cristobalite as Mr. Insley infers but that the aggregates do have an index corresponding to the mean indices of the discrete particles of which it is constituted.

The writer also believes that the conclusion reached that French flint and chalcedony both completely transform into cristobalite before sand and quartz is correct.

DISCUSSION[1] OF "ITEMS OF COST FREQUENTLY OVERLOOKED"[2]

MR. D. F. STEVENS:—For several years, most of the heavy clay products industries have alternatingly experienced a condition of no business, or so much business that costs did not make very much difference, but we are now probably in a period of considerable duration in which costs are going to become of vital importance.

There will be increasing demands for brick and tile but not a sufficient demand for a long time to come to absorb the full capacity production. Therefore the manufacturer who has his costs under the best control and is most accurate is going to have a great advantage over one who has an inadequate record of his costs.

Emphasis is often placed on the various items of expense but to arrive at a cost rate, we must have not only the items of expense but also the quantity of ware produced by which to divide these expense items and thus obtain the rate. That is where a great many men are deceiving themselves.

The total amount of green ware produced at the machine is often considered as the production of the plant, and the various items of expense are divided by this figure. As a matter of fact even before the ware is on the dryer cars there is a certain amount of damage which would result either in off-grade ware or absolutely unsalable ware. Such items of

[1] Heavy Clay Products Division, St. Louis Meeting, Feb., 1922.

[2] Owens, *Jour. Amer. Ceram. Soc.*, **5** (Bull. Sec.), 48, 1922.

loss pyramid in geometrical ratio if not itemized at each stage through the process. Very few plants make any particular effort to determine the loss and depreciation in manufactured ware as it progresses through the factory.

It is practically impossible to operate a dryer of any type without a certain amount of ware coming through damaged. Some of this will be rejected by the setters but some will be set.

Many face-brick manufacturers keep account of the number of damaged brick coming back to the machine for a short time. If the conditions remain constant so that the same amount of damaged ware will be returned each day, a constant percentage can be used in the cost determination and the manufacturer can do without the daily records of damaged ware. But the amount of ware thus returned is usually not constant. In our own case it varies to a certain extent with weather conditions and more with the conditions of our raw material. Different parts of the vein will produce more brick loss than others. We decided that it would pay to keep an exact record on every damaged brick at each stage in the manufacture, with statement of the cause.

In the case of face brick each car is a unit, hence it is easy from day to day to determine just exactly what our dryer loss is. After the ware is set, burned and drawn, we obtain records of kiln losses.

Mr. Farnham spoke of the fact that with piece work many times there will be no loss shown whatever and that there will be more good ware coming out of the kilns than was set. We operate our plant on piece work, and I know that this condition is painfully true. The only accurate way to avoid this is to count the cullage when the kilns are cleaned. If you do not want to count each individual brick, the number of wheelbarrows could be used.

In piling the ware in the yard and later when loading it, a certain amount of loss will occur which should be known.

These various leaks, each one not very great, over a period of time amount to a great sum. The total of these losses should be deducted from the machine count of the ware produced to arrive at the proper divisor to be used in determining cost rates.

Another factor of even greater importance is the loss through off-grades. Many manufacturers do not stop to consider that their off-grade ware must be sold at a small fraction of the production cost although the cost of production is just as much. It has required the same amount of fuel, labor and overhead and yet must be disposed of at a very low price, and in many cases must go to the dump. The first-grade ware must carry the loss incident to the manufacture and sale of the off-grade ware.

The most convenient and satisfactory way to arrive at a selling price for first-grade ware is to carry all off-grade ware at a low inventory rate

and then charge the difference between this and the cost of production for the period under consideration against your first-grade ware. That, of course, will materially increase the cost of your first-grade ware, but you will know that you are selling your first grade at a profit and taking care of the loss which otherwise you would incur in the sale of your off-grade ware.

I believe this is the simplest and the surest accounting system. From the standpoint of income tax returns it is the safest because it automatically carries the inventory at a deflated figure.

These two particular lines of expense, (1) loss in broken and defective ware coming through the various processes of manufacture and, (2) the off-grade ware which has to be sold at a very much less price, are frequently overlooked. Manufacturers who do not take these losses into account will think they are operating at a profit whereas actually they may be operating at a very considerable loss.

A MEMBER:—How many bricks do you put on a car, Mr. Stevens?

MR. STEVENS:—We average about 500.

A MEMBER:—Do you carry any extra brick to make up for the loss of the breakage?

MR. STEVENS:—I think the actual count of our brick is 504, and we carry the cars as 500, but we keep track of the actual loss at each stage.

A MEMBER:—We figure about 600 for the car and put on 16 extra brick. All of the breakage from the kiln is collected and weighed. We have a hopper on the return tracks to the machine in which we weigh the bricks damaged prior to burning. When we empty the kilns we clean out and weigh the waste.

MR. STEVENS:—If you are making all your product the same weight, weighing is just as well as an actual count.

MR. W. H. HERBERT (Nashville):—A short while ago I asked the transfer man to give me an accurate count of the number of broken brick on a certain number of cars. I checked this up with him and found he was turning in the number of bads as the number of brick; he had twice as many bads as he had of brick.

MR. STEVENS:—The Indiana white labor on the whole have that same degree of mentality. It is pretty hard to check them up by a count. Our records at the end of the year will be out about 200,000 brick.

MR. LANGWORTHY:—We do the same thing. Our cars hold about 500, but they fall short of that because the machine fellows are on piece work so we count 470 to the car although it figures a little bit more than this. We make seventy cars for 33,000 brick.

We also keep track of the number of bricks broken in the dryer. We call it the dryer loss, but we do not take that into account because at

the end of the year we have about 200,000 extra brick on the plant to inventory.

A MEMBER:—We do not; that 30 brick on a car covers all of our loss—the dryer loss and the kiln loss also.

MR. STEVENS:—That will run about 6%.

MR. LANGWORTHY:—But we set those extra brick. The machine men make the extra brick and the setters set them and the drawers draw them.

MR. W. H. HERBERT:—We manufacture dry pressed brick. We had a revolving counter on the machine, counting the number of bricks the machine made. As we had to assume the loss, we finally gave that up and now we count the actual bricks that go to the kiln.

MR. STEVENS:—How do you count the bricks?

MR. HERBERT:—We have a board set up near the truck. This pushes a lever which operates a counter.

MR. STEVENS:—I was talking to a manufacturer recently who told me of a friend who wanted to get the exact count to prevent the men from cheating, and they installed a checking device so that when the car loaded with ware went over this section of the track, it rang a little bell and made a record in the office.

The manager happened to be in the office one day and heard the bell ring. A very short time after that he heard it ring again, and he did not see how in the world they could have filled another car that quickly so he slipped out to the machine room and around behind the door and listened. The car was run through and then in a very short while a fellow hit this device with a sledge which would positively ring and mark up another car. That is one serious disadvantage in having the machine room on a piece work basis.

We tried that for several years and had to give it up and went back to day work because of the tendency to slight, if not actually to miscount, and at least to put defective ware on the cars. Once you get your defective ware on the dryer cars it is very difficult to eliminate them afterwards. They will be put into the kiln and share with the good brick the expense of burning and the cost of space occupied. With day work this is not so likely to happen. We are making a rather high-grade ware, and the question of quality is vital, so in our case day work makes our machine-room cost a little bit higher.

We have a monthly bonus which we give the machine-room men for steady working which does not depend on any particular day's run. This gives them an incentive to stay on the job and keep things going in good shape. Problems of that sort vary with individual conditions.

MR. POTTS:—Do you put holes in your bricks?

MR. STEVENS:—Yes.

MR. POTTS:—Three or two?

MR. STEVENS:—Two, about $1^1/_8$ inches apart. Of course, the number of holes and their spacing would vary with the clay; some clay will stand an inch and a half hole, and others will not stand an inch. Recently we changed to two holes instead of three to decrease the breakage.

Whether it is a peculiarity of our material or not, I do not know, but with two holes we get less breakage than with three smaller ones. It is true that the brick will not break half as easy with two holes.

MR. GREER:—There is one question that seems to me fundamental, and that is the unit basis for cost figuring, whether it should be the ton or thousands of brick.

It seems to me that the ton basis is the only definite basis of costs. It is the only factor that can be applied against ware of all varieties, particularly heavy bricks.

MR. STEVENS:—I think there is a good deal to what Mr. Greer says about costs varying practically in direct proportion with the weight.

We make two different styles of rough face, and one of smooth face and the weight will vary somewhat, but the various items of cost, with the possible exception of fuel, are not in proportion to the weight at all, but are in proportion to the number of bricks produced. In other words, some of our bricks that weigh about $4^1/_2$ pounds will actually cost us practically as much as a brick that weighs about 5 pounds, and the same thing is true with our floor tile. The smallest size of floor tile is 3″ x 6″, and the largest is 6″ x 9″.

The 4″ x 4″ tile involves just as much handling and just as much expense, with the possible exception of fuel, as the 6″ x 9″ tile, hence we found it was more convenient to just count the number of individual units. I can very readily see that in the case of heavier ware, such as sewer pipe and drain tile, the tonnage basis would be better.

MR. POTTS:—I always prefer a tonnage basis, because it is the only common medium. If you are making a line of drain tile from 4 to 12 inches, and a line of fire proofing up to 12 by 12 inches, you can have no other means of comparison than on the tonnage basis.

MR. AMOS:—I do not know that I can agree with either of these gentlemen. I am operating two plants combined. The shale goes to one set of bins for hollow tile and another set of bins for brick. We figure our brick costs by the thousand and, as Mr. Stevens says, the weight of the bricks makes no difference in their cost of manufacturing. You can make brick of four or of five pounds and a half, just about as cheap as you can make a brick that is smaller.

Of course, in making paving blocks, weighing eight pounds, there would be quite a difference in that cost, but as long as there is very little difference in the bulk of the brick, the difference in the weight of the brick makes practically no difference in the cost, except as to fuel.

Large, heavy brick, as a rule, will cost a little more to burn than a smaller, lighter brick. In our hollow tile plant we figure costs on the ton basis, and the service rendered to both plants in the shale pits and the power is divided between the two on a tonnage basis.

MR. TEFFT:—We make quite a few shape brick, and anything under the size of a standard brick is given a standard brick equivalent, we call it S. B. E. unit. Anything over that in a shape is given whatever the volume would be, of one and a third, one and a half or possibly two. We make some brick that would be large enough to take even a six S. B. E.

MR. DAILEY:—There is no doubt but that the question of keeping an accurate record of the production of the various departments is just as essential as accuracy in our books of account. No matter how careful we are, discrepancies will appear in our records of machine-run ware dried and set, and ware drawn from the kilns. Our aim though, is to keep these discrepancies as low as is practicable without a too burdensome system of checking. We keep our production record for these different departments by days and months and we also keep a record of each kiln showing the input and output. Just as soon as any differences other than reasonable ones occur we immediately set about correcting them.

A manufacturer considered he was producing 5,000 tons of ware per month in his plant. As a matter of fact he was producing at the machine 5,000 tons, but the total tons of No. 1 ware drawn from his kilns was materially less. We consider the output at our plant as the tons of No. 1 ware wheeled from our kilns.

I might say that we would have no faith in a cost system that was not interwoven with our regular books of account. We keep an accurate distribution of our expenses and go into it quite thoroughly by carrying a ledger account for each sub-divided item of expense for each department. As an example, our pit expenses are divided into the following, each of which has its own ledger account: pit labor, pit fuel, pit repairs and pit supplies. The total expenses shown on our cost sheets as the total of these accounts is then figured against the production of the pit in tons of ware giving of course the cost per ton. So on through our entire plant each department has from four to one dozen accounts. The departments consist of pit, machine room, drying, transferring and setting, burning, and drawing. Next comes factory overhead, or as we term it "indirect." Our overhead expenses, separated as to selling, office and miscellaneous are sub-divided just as carefully as our factory manufacturing costs are. We not only arrive at cost figures monthly but by carrying cumulative totals of our distribution as figured against cumulative production totals we have an average cost figure that is an item that I would particularly like to call your attention to.

In an industry subject to as wide fluctuations as the heavy clay products

industry is, if each manufacturer arrived at his costs carefully on an average basis as mentioned, there would certainly be a far more satisfactory condition within the industry. These averages, or cumulative figures, can be taken over a period of six months or a year, or of course it would be an ideal condition if the trade would start in and keep their average costs over an indefinite period. I would like to add that I firmly believe that selling costs should be averaged over a like period and I earnestly advise the industry to compare their average selling costs with their average manufacturing costs.

I think this covers briefly our views as to cost accounting with particular attention called to (1) the advisability of careful counting of ware for our production records, (2) the fact that No. 1 ware only taken from our kilns is what we count as production from our plant, and (3) the importance that we advise the industry to attach to cumulative or average cost figures. Ample depletion and depreciation charges are made on our books of account and since our accounting system is a part of our cost system, depletion and depreciation are of course considered in our costs.

MR. STEVENS:—Do you include interest on the investment?

MR. DAILEY:—We do not include interest on the investment as a part of our cost expense.

MR. GREENOUGH:—What have you got to say about depreciation on plants operating at less than full capacity?

MR. DAILEY:—We charge that at the same rate as we would have charged had we been running full time.

MR. GREENOUGH:—Suppose you were only running 50%, would you charge the full amount?

MR. DAILEY:—We charge the full amount just the same. I have gone on the assumption that a plant depreciates just about as rapidly running on part time as it does running on full time, or at full capacity. Possibly a reasonable exception could be taken to this although I would have to be convinced. Running at 50% capacity as compared to full capacity would of course make a depletion charge for depletion of raw material just 50% of what it would be were we running at full capacity.

Most of our work throughout our plant is on a piece-work basis and once in a long while we find that either due to an error or wilfully, our records for the output of the department will be off. With close supervision, however, these are promptly detected and if we have a reasonable doubt as to its having been a wilful miscount we do not hesitate in adjusting the record, and in some cases this adjustment almost amounts to a penalty. I can assure you that after we make these adjustments it is several months, or close to a year before the same thing is repeated. In fact the labor gang has to change almost entirely. In our plant the employees in the different departments for the most part do their own tallying and counting. Stand-

ard loading of dryer cars for each size of ware is pretty closely adhered to. Holding that the setters in our case are entitled to pay for ware rejected, we believe that this course insures as careful inspection by the setters as it is possible for us to get.

This cost system has been working for years and the longer it is in use, it follows that the more valuable it becomes to you because of the information you have accumulated for comparison.

MR. CHILD:—Whenever we get into this subject of costs, I am reminded always of a little incident that happened in Pittsburgh a few years ago.

An old Irishman had built up quite a large business. He didn't know anything about costs, and very little about accounting. He was one of those drivers that had started with nothing and had gotten several boats under his control, running from Pittsburgh down the Ohio River.

One day after they had made quite an extensive trip, he said to his bookkeeper: "Well, how much did we make on this trip?" The bookkeeper said: "Well, I am sorry I haven't got my books closed yet. I haven't got my balances."

The old fellow stood and looked at him a minute and he said: "Got your bills all paid?" The bookkeeper said "Yes." Then the old fellow said: "How much money have you left?"

I often think of that when we get to talking about costs and the greatest fallacy in cost accounting is the fact that so many firms try to put in an accounting system without tying together their general cost and their manufacturing costs per ton or per thousand. Thus over a period of five or six months they might show a profit compared with their costs but be out of line with the net profits shown when they close their books. Often there has been a tremendous loss some place along the line that they haven't taken into consideration.

We ran along for about three years, trying to keep a very itemized cost account in which every employee had a time slip. The time slip was checked at night, showing the number of hours employed on each job. The hours for each job were charged against a certain account. We are now manufacturing drain and hollow tile in sizes from 3″ to 27″, inclusive. We take our total expense for the month, based on the sales journal, We do not take consideration of our No. 2 tile or cull tile; we figure that the No. 1 tile sold has to carry the load of our entire production. Therefore, if our records show that 2500 tons were manufactured in the month, and our inventories and sales show 2300 tons a month, we have lost some place in the operation 200 tons. Therefore, the 2300 tons a month must carry the full burden of all costs.

We have never worked out a satisfactory cost for each size of tile and I don't know of anybody else who has.

We all know that the loss on a four- or five-inch tile compared to the

loss of 27″ tile amounts from 25 to 35%, but I do not see how a tile plant can work on any other basis than by the ton.

I was very much interested a few days ago when I heard Mr. Wills, who was on the Federal Reserve Board of the Cleveland District, say that the next three years would probably be the most highly competitive that this country has ever experienced. I feel that this year the selling price will be quite largely determined by the other fellow, but your own cost price is determined by yourself and nobody else, and I think that during the next two or three years the men who make a success in the heavier lines of clay products will be the fellows who spend the major portion of their energy on reducing costs, rather than on sales. I have never seen a time in my life when it was a price market so much as it is today and I think it is going to continue that way for some time.

MR. DAILEY:—Our cost system is entirely tied up with our books of account. Each subdivision of our departments has a ledger account, and it is just as much a part of our books of account to furnish information for the cost system as it is for profit and loss. Whether you count your sales as output or not would be immaterial over a long run; it would average up over a year, but why make one month's profits suffer because you happen to store ware in the yard.

MR. AMOS:—It does not; your difference in your inventories takes care of that, Mr. Dailey. For example, if you make two thousand tons, and you sold 1500 tons for the month, the difference between your inventory the first of the preceding month, and the last of the month would add to that inventory to show that you had gained 500 tons for that month.

We keep a tabulated record of our machine production, a tabulated record of our kiln production, or what goes into the kiln, and a tabulated record of the good material that comes out of the kiln, but when we get down to our cost per ton, it is based on our sales record, because if you take the emptying record, or the drawing record, your stock on the yard would still show another loss that is not accounted for. Everybody has culls that come out of their stock, and if you base it on the sales, or what you actually receive from your sales, you take care of all these shrinkages.

MR. GREENOUGH:—In other words, you check your production records by deducting shipments from your inventories?

MR. AMOS:—Yes sir.

MR. STEPHENS:—In regard to the difficulty of manufacturing both building brick and paving brick, I believe that from our own experience I might be able to say a word appropriate to that. There is as much difference on a tonnage basis, between paving brick and building brick as there is in our case between building brick and floor tile, and we find that it is the most satisfactory and not at all difficult to separate those items of operation which are distinctly different and keep those entirely separate.

For instance, our machining, setting, and drawing of the floor tile is kept entirely separate from the face brick, and the same thing in the case of the paving brick manufacturer. The paving block items should be kept entirely separate from those for the building brick. Then the general items of clay, fuel, power, drying and burning can be pro rated on a tonnage basis very properly, and the little additional effort required in keeping those special items of expense separate will be many times justified by the accurate results which can be obtained, and will not produce the confusion which a tonnage application would have, as for instance, a five pound builder and an eight, nine or ten pound paver, because there are so many items where the labor costs are so different.

MR. TEFFT:—I feel that you cannot go too deeply into finding out what the cost of each different operation of our brick manufacture actually is. You have got to know what your costs are from month to month, from year to year. If you don't know what each item costs, you cannot control them, and the man who sits in the office, or the man in charge of the plant who is not right on the ground, must make definite comparisons. Unless he has a good cost system he cannot do this.

REMARKS FOR DISCUSSION ON SILICA BRICK[1]

BY K. ENDELL:—In regard to the observation of Mr. Greaves-Walker that Findlings quartzite is similar to some found in Illinois and in old material used as Indian weapons, I might remark that chalcedony must not be confused with Findlings quartzite. The characteristic of Findlings quartzite is that it consists partly of chalcedony and partly of coarse grains of quartz crystals inbedded in the chalcedony.

The decrease of Findlings quartzite in Germany is leading to the use in larger and larger quantities of German Silurian quartzite which, in part, is very similar to the Medina and Baraboo quartzite. Most firms at present add about 50% of such quartzite to the Findlings quartzite, while some add about 80%. Occasionally silica brick are made from only such quartzites.

It is worthy of note that, thanks to the special manner of preparation of silica brick from such Silurian quartzites, only cone 14 is used in burning. They usually have a specific gravity of 2.45–2.50. Indeed the steel industry figures on a suitable expansion and allows expansion joints for the later expansion of the bricks. In figuring expansion joints, one can only rely upon the fact that this specific gravity can be guaranteed. It is to be noted that at present no standard exists.

[1] Discussion, *Bulletin, Jour. Amer. Ceram. Soc.*, **1**, 180 (1922); K. Endell, **5**, 209 (1922).

The softening temperatures for silica brick given in my paper (*Jour. Amer. Ceram. Soc.*, **5,** 216 (1922)), as determined in the Steger press, are too low. Before I went to America, I had only made a few determinations with this press and all sources of error, as in temperature measurements, were not sufficiently considered. Above 1450°C the carbon furnace gave off vapors which made the optical temperature measurements uncertain.

Careful experiments on the true softening temperature have shown that the values given are on the average about 100°C too low. I have run about 100 new determinations which gave 1520–1660°C as the softening temperature for standard silica brick. These values agree with those found in America and with some earlier values I had obtained.

Translated by E. N. BUNTING

DISCUSSION[1] ON "THE EFFECT OF SOURCES OF PIG IRON UPON THE ENAMELING OF CAST IRON[2]

BY E. P. POSTE:—The enameling industry pays too little attention to the metal that is being enameled. The past two or three years have seen the beginnings of an appreciation of this fact and it is very promising to see records appearing in the literature and to know of researches being taken up by technical organizations.

With particular reference to the subject of cast iron as a material to be enameled, there are two phases of the matter which should receive consideration: namely, the composition and structure of the iron. By structure is meant the particular manner in which the constituents, more specifically the iron and carbon, enter into combination within the casting. Bearing on the latter point it must be realized that various types of iron undergo different structural changes during the enameling operation, without changes in composition as a whole.

Some enamelers claim that any kind of mechanically good gray iron can be successfully enameled. Others hold that certain definite specifications as to composition give best results. The writer has discussed this matter with a large number of enamelers and the notes available include the following ranges of composition as having been recommended for sanitary ware:

Sulphur	0.07	to	0.09	Silicon	2.20	to	3.00
Phosphorus	.70	to	.80	C. Carbon	.20	to	.40
Manganese	.30	to	.60	G. Carbon	3.00	to	3.30

Another interesting set of compositions has resulted from analysis of

[1] Received Oct. 11, 1922.

[2] M. E. Manson, *Jour. Amer. Ceram. Soc.*, **5,** 806 (1922).

various European irons used in the manufacture of chemical apparatus. They range as follows:

Sulphur	0.05	to	0.10	Silicon	1.70	to	2.70
Phosphorus	.90	to	1.80	C. Carbon	.09	to	.20
Manganese	.30	to	.70	G. Carbon	2.90	to	3.65

The outstanding differences seem to be the higher phosphorus and the lower combined carbon in the foreign iron. The latter point may result from the fact that all the castings involved in the foreign analyses had been enameled, the enameling operation often causing a drop in the combined carbon.

With reference to the differences between southern and northern iron, the writer can offer no comment other than that his experience has been with northern iron entirely and that the type of troubles being studied by the author has not been encountered. The fact that harder, acid-resisting enamels are involved, as compared with the sanitary type, may have a bearing on this situation.

The author passes over slight differences in combined carbon as insignificant. When it is realized that this combined carbon is chemically united with iron as cementite weighing 15 times as much as the carbon involved, and that this cementite is in turn associated with ferrite to form pearlite 7.4 times as heavy as the cementite, it is seen that slight differences in combined carbon really mean quite radical differences in structural composition. As a specific case we will compare 0.10% and 0.30% combined carbon. In the former case there is 1.50% cementite and 11.1% pearlite; in the latter, 4.5% cementite and 33.3% pearlite. These structural compositions are on the basis of a well-annealed iron, a condition quite sure to follow enameling. For a thorough consideration of the various combinations of iron and carbon in cast iron the reader is referred to Chapter 6 of "Howe's Metallography of Steel and Cast Iron."

The author mentions the possibility of the formation of gases in the iron. The whole matter of the form of the graphite plates, penetration of gases, permanent growth of iron on heating and several related subjects cannot be overlooked in a thorough study of the problem. Hatfield in his book "Cast Iron in the Light of Recent Research," particularly in Chapter 10, records some very pertinent information which cannot be discussed here.

The author's micros of the various irons being studied are very interesting. There are two ways of observing the structure of iron. The use of unetched specimens reveals the nature of the graphite present while etching, as has been done in this case, brings out the other structural features, sometimes producing such a complex field that it is more difficult to note the general nature of the iron.

In researches on iron in connection with enameling the writer has encountered two types of blotches in iron. The first has been termed "nesting" of the graphite. It is best observed on an unetched specimen. This structure is not fundamentally changed on heating, as in enameling, unless the graphite plates originally present form the nuclei for the separation of more graphite from the cementite. The other type of blotches is revealed on the etching of certain irons. It is fundamentally a matter of structure other than free graphite. The annealing of the specimen results in the disappearance of the blotching and the production of a fairly uniform field.

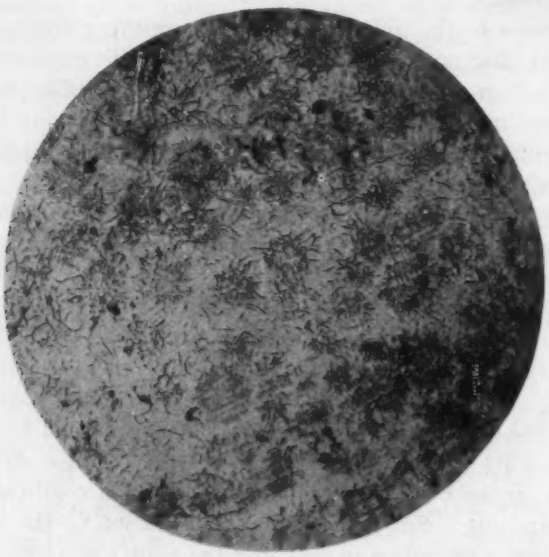


FIG. 1.

The first type of blotching is illustrated by micro No. 1 which is of an unetched specimen of the following iron:

Silicon	1.92	Manganese	0.59
Sulphur	.121	C. Carbon	.90
	Phosphorus 0.69		

This iron showed fundamentally the same structure after annealing.

The second type of blotching is shown in micro No. 2 which is from an etched specimen of the following iron:

Silicon	1.31	Phosphorus	0.39
Sulphur	.063	C. Carbon	.90
Manganese	1.18	G. Carbon	2.94

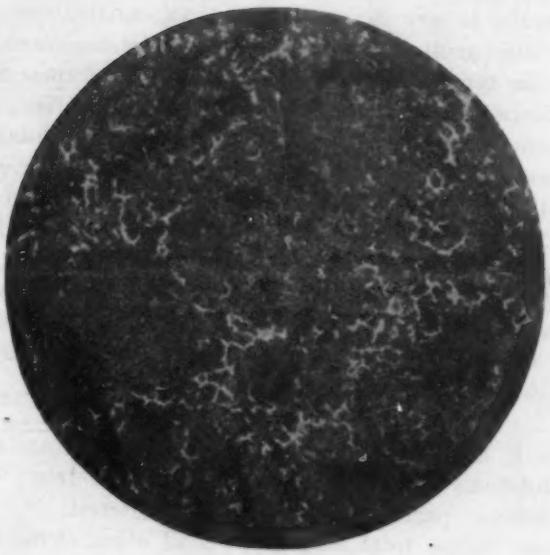


FIG. 2.

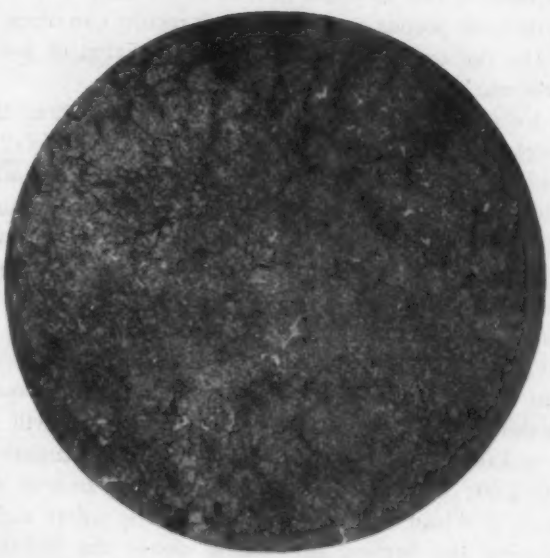


FIG. 3.

This iron after annealing is shown in micro No. 3. Apparently this metal structurally is very close to the eutectic matrix.

The writer is not at all sure that either type of blotching herein illustrated is related to the type presented by the author. But there is possibly a close resemblance between the author's Fig. 9 and the writer's micro No. 2.

If the blotches mentioned by the author are surface blotches, possibly resulting from reaction with the atmosphere through the ground coat, why is it that others do not appear after the surface has been removed by sandblasting exposing a fresh surface for the second enameling? Has the annealing incidental to the first enameling had a part in this?

The writer realizes that this discussion in no way furthers the knowledge of the matter under consideration. Perhaps it will help to bring certain new lines of thought to the problem as it seems to relate to the sanitary enameling industry.

By Homer F. Staley:—In connection with M. E. Manson's paper the following quotations from the "Metallurgy of Cast Iron" by Thos. D. West, 13th Edition, pages 246–7–8, may be of interest.

"An increase in the total carbon, with all other elements remaining fairly constant, increases the life or heat of molten metal, softens the iron, increases deflection and decreases its strength. Where high carbon exists it may cause a kish or scum to rise, which may often be the means of producing dirty or porous castings. Such results can often be remedied by lowering the carbon in mixtures, by the addition of low carbon pig metal or steels, etc."

"Allowing for changes in the percentage of total carbon, the combined carbon varies closely with those of silicon and sulphur, especially the former or, in other words, with a constant total carbon, sulphur, and manganese, etc., the higher the silicon, the lower the combined carbon and the higher the graphite, in normally made and cooled pig iron or castings."

"Very high carbon or silicon can cause metal to be sluggish or thick on the surface, at either the furnace or foundry. Such iron can often be seen evolving a great deal of kish at the furnace, or a scum at the foundry, and makes it very difficult, when in iron, to obtain clean castings.

"To obtain a thin or clean iron and one which will run quickly while it is hot, in making gray castings, use a mixture which will give castings having carbon 3.00 to 3.75, phosphorus .80 to 1.00, manganese .40 to .60, silicon 2.50 to 3.00; sulphur to be below .07. Such an iron, while running thin as long as it retains its heat, could be made softer and have longer life by increasing the carbon and silicon above the limits here shown, but by doing this the thinness, or quicksilver action, would be reduced unless phorphorus was increased, which would be liable to make the castings brittle. The higher the total carbon, the less silicon is required to maintain

the grade and the higher can the carbon be held in a combined or graphitic state, other conditions being equal."

In making castings for enameling, the writer has found the above specifications quite satisfactory with the exception that the silicon content should vary from 1.50 to 2.50. In general the lower the silicon can be kept with good foundry practice the better the enameling qualities of the iron.

Mr. Manson has done a nice piece of experimental work and has shown the practical way to overcome a difficulty that has been experienced by many enamelers. For this he deserves the gratitude of the whole cast-iron enameling industry. The above quotations are given simply to emphasize the possibility, recognized by Mr. Manson, that the trouble may be due to separation of carbon in irons with low combined carbon.

ACTIVITIES OF THE SOCIETY

THE EIGHTEEN HUNDRED MARK PASSED

The "Young Lady Across the Way" was told the other day that a set back helped a football team a lot, whereas she had always thought the players in the other positions were just as important.

This month the set back on the AMERICAN CERAMIC SOCIETY football team was just a little more prominent than any other position. A number of small gains were made but only one man really distinguished himself. This was W. C. Lindemann who bucked the Enamel line for ten yards and successfully completed two forward passes to Danielson. Sortwell and Ayars made good gains around east and west ends respectively, while Ortman, M. E. Gates, Davis Brown, and MacMichael had the ticklish end of four forward passes.

Hursh, Frost, Wenning, and Knollman gained ten yards each by line plunges. Riddle made a quick recovery of a fumble and carried the ball ten more. Dornbach, Howe, and Lambie, the refractory back field, broke through their opponents for ten yards apiece. Lord, Lyon, Rand, Cox and Wilkins filled their positions creditably and carried the ball at various times for ten yards.

The record of each man follows:

	Personal	Corporation		Personal	Corporation
W. C. Lindemann	1	2	F. H. Riddle	1	
E. E. Ayars	2		H. J. Knollman	1	
H. H. Sortwell	2		W. E. Dornbach	1	
P. S. MacMichael		1	R. M. Howe	1	
Davis Brown		1	J. M. Lambie	1	
F. B. Ortman		1	F. G. Lord	1	
M. E. Gates		1	J. B. Lyon	1	
R. K. Hursh	1		C. C. Rand	1	
L. J. Frost	1		P. E. Cox	1	
W. F. Wenning	1		W. W. Wilkins	1	
			Office	7	1

Total 25 Personal, 7 Corporation

The net increase for ten months of 1922 is:

	Personal	Corporation
Nov. 15, 1922	1593	218
Jan. 1, 1922	1350	139
Net increase	243	79

The gross increase by periods since June, 1921 is as follows:

	Personal	Corporation	Total
June to September, 1921	41	11	52
September to December	18	2	20
December to February	136	21	157
February to May	81	10	91
May	13	13	26
June	13	5	18
July	25	11	36
August	20	5	25

	Personal	Corporation	Total
September	31	11	42
October	31	12	43
November	25	7	32
Gross increase	434	108	542
Loss	82	5	87
Net increase	352	103	455

Not so many years ago an enthusiastic member of the SOCIETY was heard to say that he believed the SOCIETY could reach in time the dizzy height of 750 members. This remark was tolerated by the more conservative as youthful exuberance, gently but firmly to be suppressed.

On November 1, 1922, the mail brought into the office of the Secretary contained two personal and three corporation application cards, and the total membership was magically raised to more than 1800. Now probably some bold, young spirit will rashly declare that we shall have 3000 members in a few years. The very idea!

NEW MEMBERS RECEIVED FROM OCTOBER 16 TO NOVEMBER 15

ASSOCIATE

Alderson, Benjamin, Chemist, American Bottle Co., Streator, Ill.

Boeker, Victor W., 1111 W. Stoughton St., Urbana, Ill., Student.

Bowne, Martin S., 422 W. Locust St., Clearfield, Pa., Supt., Clearfield Sewer Pipe Co.

Bryson, Frank W., Charleston, W. Va., Supt., West Virginia Brick Co.

Davies, James A., 1727 Bryn Mawr Rd., Cleveland, Ohio, Enameling Foreman, Vitreous Enameling Co.

Dougherty, George C., P. O. Box 667, Reading, Pa., Supt., Reading Vitreous Enameling Works.

Gaardsmoe, H. L., 141 Industrial Bldg., Bureau of Standards, Washington, D. C., Research Fellow.

Keeler, R. B., 2298 E. 52nd St., Los Angeles, Cal., Pres., Southern California Clay Products Co.

Kennelley, Griffith S., 302 Union St., Joliet, Ill., Sales Representative, American Refractories Co.

Leonard, Philip C., 210 Iowa Ave., Joliet, Ill., Sales Representative, American Refractories Co.

Minnigerode, J. H., P. O. Box 935, Baltimore, Md., Foreman, American Refractories Co.

Morris, Bernard L., 50 S. 11th Ave., Coatesville, Pa., Midvale Steel and Ordnance Co.

Owen, W. G., Haws Refractories Co., Johnstown, Pa., Asst. Sales Manager.

Paxton, Elisha W., 118 Le Moyne Ave., Washington, Pa., Highland Glass Co.

Peck, J. Clair, 4961 Neosho St., St. Louis, Mo., Burn Despatcher, Laclede-Christy Clay Products Co.

Peters, M. F., 534 11th St. S. E., Washington, D. C., Associate Ceramic Engineer, Bureau of Standards.

Radcliffe, Louis C., Jr., 10500 Clifton Blvd., Cleveland, O., Salesman, Roessler & Hasslacher Chemical Co.

Rockwood, Nathan C., 542 S. Dearborn St., Chicago, Ill., Editor and Vice Pres., "Rock Products."

Scherer, Oscar, 940 McAllister Ave., Columbus, O.

Shedd, Solon, College Station, Pullman, Wash., Prof. of Geology and Head of the Dept. of Geology.

Straight, F. W., Auburn Brick & Tile Co., Gen. Mgr., Auburn, Sac Co., Iowa.

Thrower, Wm. John, Minerva, Ohio, Supt., Owen China Co.

Weidman, Frank A., 38 S. Dearborn St., Chicago, Ill., Special Representative, Inland Steel Co.

Welsford, Henry R., 2022 N. Broad St., Philadelphia, Pa., Research Laboratory, Abrasive Co., Bridesburg, Pa.

Wirick, Jean Paul, 2611 W. 62nd St., Chicago, Ill., Pottery Instructor, Technical High School.

CORPORATION

Clay Service Corp., 138 N. La Salle St., Chicago, Ill.

Elgin Butler Brick & Tile Co., Austin, Texas.

Hadfield-Penfield Steel Co., Bucyrus, Ohio.

Mansfield Sheet & Tin Plate Co., Mansfield, Ohio.

Northern Clay Co., Auburn, Washington.

Portsmouth Stove & Range Co., Portsmouth, Ohio.

Tropico Potteries, Inc., Glendale, Calif.

WHO'S WHERE IN THE AMERICAN CERAMIC SOCIETY?

Earl B. Baker, one of the crew of the U. S. Bureau of Mines Laboratory Car, has recently accepted a position with the Southern Clay Company, of Robbins, Tenn.

Daniel D. Berolzheimer, Assistant Technical Editor of the Chemical Catalog Co., Inc., notifies us that the offices of the company have been moved from One Madison Ave. to 334 Fourth Ave., New York City.

A. W. Bitting, Director of Research of the Glass Container Association of America, has moved from Chicago to 1912 Clinton Ave., Alameda, Cal.

Mrs. J. T. Bramlett is now living at 1698 Glenview Ave., Memphis, Tenn.

O. O. Bowman, 2nd has severed his connection with the Trenton Fire Clay and Porcelain Company and is giving all his time to the Bowman Coal Co. of which he is Secretary and Treasurer. His address is the Broad Street Bank Bldg., Trenton, N. J.

Robert Brewster, formerly of Chicago, has taken up his residence at 119th and 86th Sts., Palos Park, Ill.

Albert D. Busch, of the W. S. Tyler Co., has changed his address from Pershing Ave. to 4945 Spalding Ave., St. Louis, Mo.

C. V. Cameron, formerly of Richmond, Cal., is now with the Whiting-Mead Commercial Co., 2035 E. Vernon Ave., Los Angeles, Cal.

Rod. Castro Oliveira, who has been studying at the New York State School of Ceramics, Alfred, N. Y., for the past three years, is on his way home to Santiago, Chile, and is at present in England.

Dorothy Peck Chapman has moved from Greenfield, Mass., to 131 N. 19th St., East Orange, N. J.

A. L. Duval d'Adrian, formerly of Washington, Pa., is now located at Alton, Ill.

Leon E. Ells, who graduated from the New York State School of Ceramics last June, is with the Laclede-Christy Clay Products Co., St. Louis, Mo. His address is 4425 A Flad Ave.

T. W. Garve, of the Ceramic Supply & Construction Co., has changed his residence to 55 N. 20th St., Columbus, Ohio.

Wm. H. Grueby has recently changed his address from Perth Amboy, N. J., to 680 Madison Ave., New York City, where the Exhibition Rooms of the Grueby Faience & Tile Co. are situated.

Herman A. Hall, who is with the Medina Clay Products Co., Medina, Ohio, recently called at the office of the Secretary and denied the rumor that he had been "lost."

Fred T. Heath, of the Heath Unit Tile Co., has been transferred from Seattle, to Tacoma, Wash., where his address is the Puget Sound Bank Bldg.

Joseph W. Hoehl has moved from Piqua, Ohio, to Detroit, Mich., where he is with the Wolverine Porcelain Enamel Co.

W. W. Ittner, Treasurer of the General Clay Products Corp., St. Louis, Mo., gives as his new home address 5141 Waterman Ave.

Walter A. King, of the Elyria Enameled Products Co., is now living at 149 Branston Ave., Elyria, Ohio.

Charles Laird, formerly of St. Louis, is now affiliated with the Southern Clay Mfg. Co., North Birmingham, Ala.

J. S. Laird has moved from Charleston, W. Va., to Imlay City, Mich.

A. Malinovszky is with the Washington Iron Works, Los Angeles, Cal.

C. R. Minton, who graduated from the Ceramic Department of Ohio State University last June, has accepted a position with the Los Angeles Pressed Brick Co., Los Angeles, Cal.

J. A. Nagle, of the Pittsburgh American China Co., has gone from Columbus, Ohio, to live at 315 Center Ave., Greensburgh, Pa.

Fred H. Schwetye, of the Laclede-Christy Clay Products Co., has changed his address from Manchester Ave., to 5445 Queens Ave., St. Louis, Mo.

B. T. Sweely, formerly with the Coonley Mfg. Co., Cicero, Ill., has recently accepted a position with the Cribben & Sexton Co., Chicago, Ill.

A. J. Walcott, who last month appeared among the "lost," has notified the office that he is doing graduate work in the Department of Geology at Northwestern University, Evanston, Ill.

R. H. White, of the Norton Co., is now living at 617 Buffalo Ave., Niagara Falls, N. Y.

C. L. Wigfield, of the Elyria Enameled Products Co., has moved from W. Broad St. to 438 Cleveland St., Elyria, Ohio.

NO ADDRESSES

The list of unknown addresses remains about the same. Some are located each month, but a few others are A.W.O.L. Information will be gratefully received by the Secretary.

Baker, G. V., Penn Feldspar Co., Philadelphia, Pa.
Bickel, Earl A., Postville Clay Products Co., Postville, Iowa.
Brett, R. C., Southern Clay Mfg. Co., North Birmingham, Ala.
Callaghan, J. P., c/o Teaque Hotel, Montgomery, Ala.
Dolley, Charles S., Keramoid Mfg. Co., Fort Madison, Iowa.
Greenwood, John L., Lehigh Sewer Pipe and Tile Co., Lehigh, Iowa.
Groocock, Alice, 865 Bathurst St., Toronto, Ont.
Kitamura, Y., Shofu Kogo Kafushiki Kaisha, Kyoto, Japan.
Knote, J. M., Mines Dept., Sault Ste. Marie, Ont.
Lodwick, J. A., American Arch Co., 17 East 42nd St., New York City.

Mitchell, Leon W., Rock Island Stove Co., Rock Island, Ill.
Morrow, Robert P., Harbison-Walker Refractories Co., 1513 Rockefeller Bldg., Cleveland, Ohio.
Okura, K., 84 Kobayashi-Cho, Nagoya, Japan.
Pendrup, W., Coonley Mfg. Co., Cicero, Ill.
Pulsifer, H. M., Geo. H. Holb & Co., Chicago, Ill.
Ragland, N. A., Alberhill Clay and Coal Co., Los Angeles, Cal.
Reid, W. H., 10 Stanley Place, Yonkers, N. Y.
Stewart, John G., 530 Union Trust Bldg., Cincinnati, Ohio.
Van Moore, A. L., American Photo Glass & Export Co., New Eagle, Pa.
Vodick, William J., 1733 Lake Ave., Wilmette, Ill.
Yamamoto, Tamesburo, Yamatame Glass Mfg. Co., Osaka, Japan.

AN EXTRA INDUCEMENT

It has been voted by the Board of Trustees to allow new members now to join the SOCIETY for 1923 and to purchase the *Journal* for 1922 at member's rate, if they desire.

Persons who wish to take advantage of this offer will therefore pay

Dues for 1923	$7.50
Journal for 1922 at member's rate	4.80
	$12.30

and obtain the principal privileges of membership for two years at a saving of $2.70.

Members are urged to use this argument in connection with their invitations to others to join the SOCIETY.

ASK THAT MAN TO JOIN

There are many who would join the SOCIETY when the opportunity is presented. Here is a letter typical of several we have received:

> "Mr. S. F. Walton of the Northern Refractories Co. has advised me that I can join your Society. I am greatly interested in the Refractories Division and, if agreeable, will you kindly send application blank and bill for dues."

ADVANCE NOTICE SECOND ANNUAL CERAMIC EXHIBITION

Twenty-Fifth Annual Convention American Ceramic Society

JAMES C. BOUDREAU, DIRECTOR OF ART EDUCATION, 725 FULTON BLDG., PITTSBURGH, IS CHAIRMAN OF THE COMMITTEE ON EXHIBITION

In planning for the second Ceramic Exhibition to be held during the coming Convention in February, it is obvious that this should be in harmony with the occasion of the celebration of the Twenty-Fifth Anniversary of the founding of the AMERICAN CERAMIC SOCIETY.

Not only should the present ceramic field be adequately represented, but where possible, examples showing the development during the past twenty-five years should be included.

No one will question the accomplishments in American ceramics during this comparatively short space of time. No other country can show such technical and practical development within such a short period. But unfortunately, there have been few opportunities to show collectively the various types of ceramic work together with examples showing developments covering a period of years.

The Exhibition last year was the first attempt to do this, and the result was successful enough to make the Exhibit an annual event.

Members of the SOCIETY are urged to coöperate in making this Exhibition a distinctive event.

Members having examples of early American pottery and glass are asked to loan these during the period of the Exhibit.

Every care will be taken of the exhibits, and expert packers will be engaged to pack for return shipment.

The various exhibits will be classified as follows:

A.	Utilitarian White Ware	J.	Chemical Stoneware
B.	Electrical Porcelain	K.	Utilitarian Stoneware
C.	Chemical Porcelain	L.	Sewer Pipe
D.	Sanitary Ware	M.	Enameled Ware
E.	Terra Cotta	N.	Glass
F.	Building Brick and Tile	O.	Refractories
G.	Floor and Wall Tile	P.	High School Pottery
H.	Faience	Q.	Universities and Bureaus
I.	Art Pottery		

The Universities and Bureaus are urged to exhibit examples and methods of research.

Exhibition blanks and shipping tags will be sent out at a later date.

The Exhibition Committee Personnel:

Chairman: James C. Boudreau
White Ware: Lawrence Brown
Heavy Clay Products: C. Forrest Tefft
Glass: J. C. Hostetter
Refractories: R. F. Ferguson
Enamel: B. T. Sweely
Art: F. H. Rhead
Terra Cotta: R. L. Clare

CHICAGO LOCAL SECTION

A letter to the members of the Chicago Section of the AMERICAN CERAMIC SOCIETY has been issued by the Chairman, F. L. Steinhoff, calling the sixth annual meeting for Saturday, December 2. The program committee is putting forth special efforts to secure excellent papers and speakers for the occasion, and a large attendance is anticipated.

INQUIRIES FOR TECHNICAL INFORMATION RECEIVED FROM READERS DURING OCTOBER

The following questions pertaining to ceramic problems have been received by the Secretary of the SOCIETY recently. These problems presented are typical of the many which come in every month. Members who are interested in discussing these questions may send their discussions to the Editor's office (Lord Hall, O. S. U., Columbus, O.) where they will be edited and published.

(1) A chemical engineer wishes advice regarding refractories to withstand about 3600°F generated by an oil burner. Fire brick readily melts.

(2) Please advise where I can get a formula for engobe coating for use under glaze on solid porcelain material.

(3) I am in the stoneware and flower pot business and am especially interested in glazes for stoneware bodies. If the CERAMIC SOCIETY has anything on this subject would be pleased to receive same.

(4) Would you please advise as to the materials used, and their proportions, for white vitreous floor tile.

(5) We have used several different formulas for brown glazes for insulators each showing a variation in color in burning. Could you suggest a formula of a glaze that would be more stable in color?

(6) Would you be good enough to give us a list of glass sand manufacturers?

(7) We have, from time to time, been purchasing fused silica scrap in quantities of a few hundred pounds. Our requirements have increased so that in the future our purchases will be lots of several tons. Can you tell us how it is produced and whether it is a commercial product? Can you tell us which manufacturers or class of manufacturers would be most likely to be in position to supply us?

(8) Do you know of a book entitled "Laws and Rules of Clay Mining?"

(9) Can you give us a comparison of the melting points of German and Orton cones?

(10) I am anxious to get what data I can on the cost of handling different clay materials in the factory. I am naturally more interested in tiles than anything else, but articles on the costs and the best way of handling, not only tiles, but terra cotta or porcelain of any kind, would help me. I do not know if you have any articles of this kind, but if you have, I wish you would kindly send them to me with a bill for the same.

PUBLICATIONS OF THE AMERICAN CERAMIC SOCIETY

Single Volumes of the *Transactions* and *Journal* and separate numbers of the *Journal* may be obtained through the office of the Secretary. Members are allowed 40% discount from list for all Volumes of the *Transactions* and for all other than the current numbers of the *Journal*. The list prices are as follows:

Transactions			
Vol. I	1899	110 pages	$4.75
Vol. II	1900	278 pages	in complete set only
Vol. III	1901	238 pages	$4.75
Vol. IV	1902	300 pages	$5.50
Vol. V	1903	420 pages	out of print
Vol. VI	1904	278 pages	$6.50
Vol. VII	1905	454 pages	$6.50
Vol. VIII	1906	411 pages	$6.50
Vol. IX	1907	808 pages	out of print

	Transactions		
Vol. X	1908	582 pages	in complete set only
Vol. XI	1909	632 pages	$6.50
Vol. XII	1910	882 pages	out of print
Vol. XIII	1911	837 pages	$6.50
Vol. XIV	1912	888 pages	in complete set only
Vol. XV	1913	747 pages	$8.00
Vol. XVI	1914	611 pages	$8.00
Vol. XVII	1915	815 pages	$8.00
Vol. XVIII	1916	947 pages	$8.00
Vol. XIX	1917	707 pages	out of print

	Journal			Single Nos.
Vol. I	1918	892 pages	$6.00	60c.
Vol. II	1919	1030 pages	$6.00	60c.
Vol. III	1920	1016 pages	$6.00	60c.
Vol. IV	1921	1050 pages	$8.00	75c.
Vol. V	1922	1671 pages	$8.00	75c.

A complete set of the *Transactions*, minus Vols. V, IX, XII, and XIX which are out of print, may be purchased at.....$150.00.

(Second-hand copies of Vols. V, IX, XII and XIX are sometimes available. Orders for these should be filed with the Secretary.)

To members of the SOCIETY a reduction of 40% will be made from the above prices. Members cannot purchase more than one copy of each volume at members' rate.

The SOCIETY has also published the following books, which will be sold net, at the prices listed, to the public and members alike:

"The Collected Writings of Dr. Hermann August Seger," Vol. I, (*a*) Treatises of a General Scientific Nature. (*b*) Essays and Refractory Wares. 552 pages. Bound in cloth..... $7.50

"The Collected Writings of Dr. Hermann August Seger," Vol. II, (*a*) Essays on White Ware and Porcelain. (*b*) Travels, Letters and Polemics. (*c*) Uncompleted works and extracts from the archives of the Royal Factory. 605 pages. Bound in cloth..... $7.50

"A Bibliography of Clays and the Ceramic Arts," by Dr. John C. Branner, 1906. 451 pages. Bound in cloth. Contains 6027 titles of works on Ceramic subjects..... $2.00

"Collective Index to the *Transactions of the American Ceramic Society*," compiled by E. J. Crane..... $1.50

ELECTRIC FURNACE FOR GLASS MANUFACTURING

An Inquiry from Dr. M. E. Holmes, Acting Secretary and General Manager of National Lime Association

During the past months I have been in correspondence with a number of people on the subject of furnaces for glass making. As is well known the ordinary glass tank furnace is notoriously inefficient; only about 10% of the heat is utilized. The question has arisen regarding the utility of an electric furnace which of course might be insulated in such a way as to make the heating efficiency very much higher. In these days of fuel shortage it seems especially important to call the attention of the AMERICAN CERAMIC SOCIETY to this fundamental problem.

If there is any way in which interest in this matter could be stimulated so as to initiate research work on a commercial scale, it seems as if it would be well worth while. I would appreciate very much if you could see your way clear to lay this matter before one of your Committees or refer the matter to Dr. Tillotson, or give it your personal attention. I am informed by one of the electric companies that they believe there are important possibilities in the development of an electric furnace for glass manufacture. If such a project should be successful it would tend of course to concentrate the glass industry at Niagara Falls, but I can see no serious objection to that.

A MESSAGE FROM THE CHAIRMAN OF THE RESEARCH COMMITTEE

By Wm. M. Clark

Referring to your letter regarding featuring research work and encouragement of research by the Society in the December issue, I have been trying to think of some constructive suggestions.

One activity it might be well for the Society to consider is the establishment of some prizes or medals to be annually awarded for research work to students in colleges, technical schools and even high schools, resulting in essays or theses to be published in the *Journal*. Some of the technical societies have considerable funds for this purpose. Perhaps the American Ceramic Society has only limited funds, but even an appropriation of $100 or $200 to be divided up into a series of prizes might serve as a starter and some gifts might result later. For example this society might have an Orton medal similar to the Nichols and Grasselli medals, etc. Would suggest grading the prizes and making the minor grades a paid up membership in the Society.

Then again we should give a broad definition to the term "Research" and not make it appear too much of a pure science nature, for instance some such definition as "Keeping One's Eyes Open." Following out this thought we should ask manufacturers and ceramists in general to be observing, noting peculiar results, crystals, fusions, corrosion effects, freakish products, unusual troubles, remarkable results and to save samples and note conditions that produced such effects. Next if the interest of the schools where thesis work is carried on can be excited and they can be told that such and such problems exist and that samples may be obtained from Mr. Blank, we may make some progress in bringing the man who has a problem and the man who can help solve it together.

Each problem should first be brought to the attention of the chairman of the Research Committee of the Division, representing the industry to which the problem or observation belongs.

COMPARISON OF JOURNALS

	1921	1922
Original Papers in Journal Section	74	103
Original Papers with Discussions	5	20
Number of Abstracts	765	1530
Original Papers in Bulletin	No Bulletin	15
Discussions in Bulletin	No Bulletin	44
Pages	1050	
Original Section		944
Abstracts		340
Bulletin		387
Total pages	1050	1671

An increase in size of type page from:

$4'' \times 6\ 1/4''$ to $4\ 1/2'' \times 7\ 1/4''$

makes an increase of about 26% more space filled on each page. This larger type page first appeared in May, 1922.

NOTES AND NEWS

REPORTS FROM THE CERAMIC ENGINEERING DEPARTMENTS OF OUR UNIVERSITIES

The Ohio State University

The enrollment for the current year is as follows:

Sophomores	22
Juniors	10
Seniors	12
Graduate Students	4

The freshmen have not indicated their choice of courses so that the enrollment can only be estimated.

The equipment of the Department has been increased during the past year by the addition of a gas and oil fired muffle kiln with inside dimensions $2'\ 0'' \times 2'\ 0'' \times 2'\ 6''$ (for the study of terra cotta). Recording and indicating pyrometers from The Brown Instrument Co. and The Bristol Co., have also been received, which add greatly to the laboratory equipment. The Maxon Furnace & Engineering Co. have furnished a No. 1 Maxon Burner, thus improving the furnace equipment.

The change in the teaching schedules from two semesters to three quarters will increase the efficiency by permitting more concentration in the different courses, fewer subjects being studied at any given time.

The graduates of the Class of 1922 are located as follows:

E. R. Curry, Gladding McBean & Co., Lincoln, Calif.
A. L. Donnenwirth, Jeffery-Dewitt Insulator Co., Kenova, W. Va.
H. E. Ebright, The Ferro-Enameling Co., Cleveland, O.
R. E. Hanna, Atlantic Terra Cotta Co., Perth Amboy, N. J.
R. S. Kane, Jeffrey Mfg. Co., Columbus, O.
P. W. Lee, Heinz Roofing Tile Co., Denver, Colo.
C. R. Minton, Los Angeles Pressed Brick Co., Los Angeles, Calif.
D. M. McCann, The Sterling Grinding Wheel Co., Tiffin, O.
Burnette Purcell, National Fire Proofing Co., Aultman, O.
Willard Stief, Mount Clemens Pottery Co., Mount Clemens, Mich.
B. E. Whitesell, Kier Fire Brick Co., Salina, Pa.

The Student Branch of the AMERICAN CERAMIC SOCIETY was regularly organized for the 1922–1923 school year on October 24. The following officers were elected:

Chairman, C. A. Smith,
Vice Chairman, Edward Burkhalter,
Sec.-Treas., A. B. DeVol.

Meetings will be held on the first Tuesday night of each month and talks by prominent ceramic men will be given.

At each meeting a member of the senior class makes a short talk reporting on some practical ceramic experience gained through summer work.

New York State School of Ceramics

The registration figures at Alfred show the present student body distributed as follows:

	Men	Women	Total
Graduate Student	1	0	1
Seniors	10	2	12
Juniors	20	7	27
Sophomores	20	11	31
Freshmen	18	7	25
	69	27	96

This number is eight less than last year when an exceptionally large freshman class entered, still shown in the number of sophomores.

The staff of the engineering department has undergone no changes but in the Applied Art department Miss Erna Sonne, a graduate of the Rhode Island School of Design and recently Assistant Supervisor of Art in Syracuse, has taken the place of Miss Nelson, former Associate Professor of Design, who is now teaching in the Toledo Art Museum School.

On account of the large number of lower class men in the laboratories, adjustments have been made whereby the former furnace room has been converted into a Senior laboratory, and the furnaces have been assembled in the few vacant places left in the kiln house. On account of the lack of funds no important changes of equipment have been possible. The force of instructors is increasingly pressed for time and laboratory space for classes, and it is hoped that the efforts continually being put forth for increased appropriation may soon show results.

Graduates of last June are placed as follows:

Robert H. Armstrong, Fiske & Co., Watsontown, Pa.
Donald Bassett, National Fireproofing Co , N. Canton, Ohio
Robert Boyd, Sinclair Oil Co., Wellsville, N. Y.
Robert Clark, 560 Elmwood Ave., Providence, R. I.
Leon B. Coffin, Onondaga Pottery Co., Syracuse, N. Y.
Max D. Compton, Los Angeles Pressed Brick Co., Los Angeles, Cal.
Leon E. Ells, Laclede-Christy Clay Products Co., St. Louis, Mo.
J. Clair Peck, Laclede-Christy Clay Products Co., St. Louis, Mo.
Thomas C. Walker, Mosaic Tile Co., Matawan, N. J.
Alfred Whitford, Fiske & Co., Watsontown, Pa.

The Student Branch of the AMERICAN CERAMIC SOCIETY has begun its work and officers for the year have been elected as follows:

President, John McMahon
Sec.-Treas., Harold Rogers
Councilor, J. B. Shaw

University of Illinois

The new school year has opened with an attendance of 77 undergraduates, distributed as follows:

Seniors	18	Sophomores	22
Juniors	18	Freshmen	19
Graduate Students	3		

Besides these students registered in the course, there are several students coming from other departments in some of the classes.

The Department staff has undergone quite a change during the past summer. Dr. E. W. Washburn, former head of the Department has resigned and is now in Washington as Editor of Critical Tables which are being published by the National Research Council.

G. R. Shelton, Corning Glass Works Fellow, who has been working in the Department for some time on glass research problems completed the requirements for his doctor's degree in June. He is now a member of the staff of the Department of Chemistry of the University of Saskatchewan.

E. E. Libman who has been connected with the Department as instructor since 1918 received his doctor's degree in June and has been transferred to the Mathematics Department, where he is now an instructor.

Roger Doyle, laboratory attendant, after being with this Department for a few months has withdrawn to enter industrial work.

T. N. McVay, a graduate of this Department in 1914, and since employed in various plants engaged in the manufacture of clay products, has joined the staff as instructor.

It is expected that another instructor will shortly join the staff.

The Department has been quite fortunate in being able to add several important items to its equipment. We have purchased and installed a No. 328 auger brick machine with a side cut-lubricating brick die, one 5″ x 8″ hollow block die, one 4″ drain tile and one 8″ drain tile die, together with other items which especially adapt this machine for class instruction. This machine was purchased from the Hadfield-Penfield Steel Company of Bucyrus, Ohio.

Also, we have increased our pottery equipment by three standard jiggers and three standard pulldowns purchased from the Crossley Machine Company, one revelation pottery kiln made by the H. J. Caulkins Company, and a wall indicator with twelve point switch box furnished by the Charles Engelhard Company for use with the various furnaces and kilns.

The course in Ceramic Chemistry which was formerly known as the course in Ceramics is now in operation. This course is designed for the special training of ceramic chemists and differs from the course in ceramic engineering by the substitution of a larger amount of chemistry for engineering topics. Some years ago before the Department was transferred to the Engineering College a similar course was provided which, according to our recollection, was done at the instance of Ross C. Purdy who was in charge of the work at that time. This course seems to be attracting gratifying attention on the part of students who are looking forward to doing work of a purely chemical nature.

Our senior students will leave in charge of Professor Hursh on the annual inspection trip October 26, going to St. Louis where they will visit the following plants:

Laclede-Christy Fire Brick Company; Evens and Howard Fire Brick Company; Hydraulic-Press Brick Company; Mississippi Glass Company; Alton (Illinois) Paving Brick Company; Illinois Glass Company, Alton, Illinois.

Graduates of last June are scattered widely.

R. E. Arnold—Westinghouse Electric and Mfg. Co., Pittsburgh, Pa.

D. B. Atwell—Evens and Howard Fire Brick Company, St. Louis, Mo.

I. B. Branham—Batchelder Wilson Tile Co., San Diego, California.

H. T. Coss—on the staff of the Department of Ceramics at Rutgers College, New Brunswick, N. J.

J. R. Green—North Iowa Brick and Tile Company, Mason City, Iowa.

J. Lathrop—Tropico Potteries Company, Glendale, California.

R. E. Lowrance—Matawan Tile Company, Matawan, N. J.

Student Societies

The Student Section of the American Ceramic Society held its first meeting on Thursday, October 12. The officers for the current year are:

O. S. Mundy, Chairman
S. Q. Lee, Secretary-Treasurer.

The officers of the *Keramos* fraternity are:

H. G. Wolfram, President
S. O. Neiswanger, Vice-President
P. F. Larson, Secretary
H. T. Leverenz, Sergeant-at-Arms.

Iowa State College

The Ceramic Department of Iowa State College has 11 students in course distributed as follows: two Freshmen, four Sophomores, four Juniors, and one Senior.

To the faculty has been added this year Miss Ethel J. Bouffleur, University of Washington, who will teach pottery decoration and handmade pottery.

A steel-jacketed kiln with removable crown and with three fire boxes, all designed to make possible the use of any sort of fuel, to make heat balance computations easily, and to carry on any ordinary ceramic firing process under approximately commercial conditions, has been built by student labor from designs by Professor Cox. Parts are at hand for the building of a test furnace for refractories after the drawings and descriptions in the October, 1922, issue of the *Journal* as presented by Professor Moulton. Since nothing but a portable kiln has been in the Department for some years these two kilns help greatly.

In ceramic engineering no new courses or changes have been made. It has been decided to manufacture pottery in a limited way to demonstrate the use of Iowa clays and shales in finer wares than are now made and to satisfy requests that make this plan advisable.

Wayne E. Barrett, who graduated last year, is located with the Adel Clay Products Co., Adel, Iowa. Leslie R. Alt, who would have finished this year, has elected to spend a year in putting into running condition a plant that belongs to the firm of which his father is general superintendent. He will return for his degree later.

The Student Branch of the American Ceramic Society at Ames is the required Seminar. It meets weekly at the day and hour set into the college calendar. The program is made up by a student member, the same man serving throughout the year. Faculty men from all over the campus are invited to talk on matters of interest to the ceramist, from choice of electives to how the physical chemist will help the ceramist, and each member talks once during the year on some subject that pleases him. Frequent use is made of the excellent visual instruction service available at Ames. Bruce F. Wagner, President, Robert C. Boyd, Secretary, and Benjamin W. Willson, Treasurer.

Frequent meetings are held in addition to the regular meetings as the Department is active in all college affairs and finds time to match showings with the more robust departments of Iowa State College.

Rutgers College

The number of ceramic students at Rutgers College and the State University of New Jersey is steadily increasing and on Registration Day, September 19th, the total enrollment was 28, classified as follows:

2 Seniors	8 Sophomores
8 Juniors	10 Freshmen.

Two new instructors, namely C. C. Clarke, B.Sc. (Colgate), M.Sc. (Rutgers) and H. T. Coss, B.Sc. (Illinois), have been added to the teaching staff.

Practically all of the machinery and equipment has been installed at the new building and laboratory work is progressing at a rapid stride.

The student organization, the Rutgers Ceramic Club, held its first meeting on October 19th in the lecture room of the new building. Following the business meeting and election of officers, a very interesting and instructive talk on Enameled Brick was given by Mr. Chas. E. Jacquart of the American Enameled Brick and Tile Co., South River, N. J. Mr. R. H. Minton and Professor G. H. Brown are the Councilors of the Club.

A TEN WEEKS' COURSE

Professor Hewitt Wilson who will have charge of the ceramic courses given at the College of Mines, University of Washington, sends the following notice which is being distributed for the purpose of advertising this course. Readers of the *Journal* will be interested in reading the variety of subjects given especially in the ceramic department.

27th Annual Winter Mining Session

COLLEGE OF MINES, UNIVERSITY OF WASHINGTON, SEATTLE
JANUARY 4–MARCH 21, 1923

QUARTZ MINING

Ore Mining Methods	Ore Milling	Geology and Mineralogy
Drilling and Blasting	Mining Law	Principles of Chemistry
Forge and Foundry Practice	Mine Surveying	Fire Assaying (Gold-Silver)

PLACER MINING

Dredging for Gold	Hydraulics	Electric Blast Firing
Testing Placer Ground	Boring Methods	Melting and Refining Gold

COAL MINING

Mine Rescue, First-Aid	Analysis of Coals	Coal Washing Methods

CERAMICS

Clay Testing	Stoneware	Glaze Studies
Lime, Plaster, Cement	Whiteware	Clay Technology
Common and Face Brick	Refractories	Terra Cotta Manufacture

Expenses Consist of Laboratory Deposits for Material Actually Used and University Fee of $20.00. Thorough Equipment Is Available for All the Above Courses. No Previous Training is Required for Entrance. Anyone Who Can Read and Write English May Enroll.

A Postal Card to the College of Mines, Seattle, Will Bring Full Details Regarding this Session and the Regular University Courses.

GLASS EXPERTS WANTED BY TARIFF COMMISSION

Under the extended duties of the Tariff Commission in the Tariff Act of 1922 an increase of its technical staff is now under consideration.

Three or four men may be selected for schedule, two of which embrace the ceramic industries, and candidates qualified in glass will receive the first consideration.

The duties of appointees consist in collecting and assembling costs of production, prices of wares, marketing conditions, foreign and domestic, in brief, all the factors

that enter into the question of competition between materials and wares of domestic and foreign production.

Technical training is essential in order to enable the appointee to understand and analyze manufacturing principles, conditions and difficulties. But a knowledge of wares from the point of view of the buying public, that is to say, for utility and attractiveness, is no less needed.

UNITED STATES TARIFF COMMISSION
John F. Bethune
8th and E Street, N. W.
Washington, D. C.

RESEARCH—A CONSTRUCTIVE TRADE ASSOCIATION ACTIVITY[1]

A Message from the U. S. Chamber of Commerce

The value of scientific research, both from an economic and an industrial standpoint, has never been so fully appreciated as at the present time. The problems of the recent war forced science and its research activities to the front in all the civilized countries of the world. It is now realized by leading manufacturers that scientific investigation is a necessary adjunct to efficient operation. A utilization of the scientific knowledge now available, and a sympathetic coöperation in the free interchange of such information will lead to the adoption of improved manufacturing processes and do much to obviate the dangers of ignorant, destructive competition. The realization of this fact is shown by the 500 or more firms now maintaining laboratories for industrial research.

If there were no correlation of effort on research work, much duplication might result. The logical solution, therefore, is to have the trade association make this correlation. This enables a pooling of resources to maintain a central laboratory to render service to a larger group than is possible with only individual laboratories. Another and very important factor, especially valuable in strengthening trade associations, is that such centralized research work makes it possible for the small manufacturer, financially unable to support an individual laboratory, to profit from the investigations carried on.

TRADE ASSOCIATIONS CONDUCTING RESEARCH

It is not surprising, therefore, that a continually increasing number of trade associations are realizing the value of research as one of their most constructive activities. Of the 65 to 70 associations now engaged in this work to whom recent inquiry was sent by the Fabricated Production Department, 33 gave specific replies, indicating that 8 were conducting their research independently and 25 were acting in coöperation with some other agency. The general leaning is toward the scientific aspect of research work, as 19 are engaged exclusively in that class, 3 on general problems and 11 give attention to both types of problems.

In classifying the nature of association research work, the terms scientific and general have been used with the following meanings:

Scientific: When it relates to the chemical, physical, bacteriological or purely technical problems of an industry.

General: When it relates to the mechanical methods used in production, distribution, etc., and the study of non-technical and non-scientific problems of the trade.

An enumeration of the wide range of problems these associations are working on is not possible in a brief bulletin such as this.

[1] *Bulletin* issued by Fabricated Production Department, Chamber of Commerce of the U. S. A., E. W. McCullough, Mgr.

Coöperating Agencies

In the same manner that coöperation of manufacturers through their association prevents duplication, so does the coöperation of associations likewise prevent unnecessary waste of effort. There are a large number of technical and scientific agencies, both governmental and private, which welcome the active participation of trade associations in their research efforts. Only a few typical cases can be mentioned here, such as Forest Products Laboratory, Mellon Institute of Industrial Research, Bureau of Mines, Bureau of Standards, University of Illinois Engineering Experiment Station, Institute of Industrial Research and National Research Council. These are but a few of the 35 agencies which we know are already working on these problems, and there are, doubtless, a good many others, both public and private, which have been engaged in research for a number of years.

The Cost of Research

Probably few fields of association activity will produce greater ultimate returns than research. The Director of the Mellon Institute of Industrial Research is authority for the statement that "some one has estimated that one-half billion dollars is being saved annually through research for industry in the United States alone. It is not surprising to learn, therefore, that about $35,000,000 is being spent annually by American manufacturers in the conduct of laboratory research. No doubt, a like amount is expended in experimental and development work in the plants, that is, beyond the laboratory stage."

No specific statement of the cost of this work can be made as it varies according to the kind and amount of the work undertaken. Associations reporting to us give as their appropriation amounts varying from a few hundred dollars up to over $100,000 annually. Whatever the amount may be there is no doubt but that it is amply repaid in benefits secured.

Conclusion

The Fabricated Production Department is convinced that scientific research is an extremely important activity in which trade associations may engage legally and with great benefit to their members and the public generally. We stand ready to assist those associations desiring to undertake this work and the resources of the department are available to all those who wish to make use of them. We invite an expression of your opinion and an opportunity to serve you.

WHITEWARE STUDY IN PACIFIC NORTHWEST UNDERTAKEN BY THE U. S. BUREAU OF MINES

In the investigation of the white clays of the Pacific Northwest being made by the Seattle, Washington, experiment station of the Bureau of Mines, samples of kaolin were recently taken at Freeman and Mica, Washington, and at Joel and Troy, Idaho. The kaolins sampled will also be used in the refractory studies, in the hope that the quality of the fire brick from the companies operating in the district can be improved. The residual deposits of clay are more difficult to operate because of the lack of uniformity and the large quantity of decomposed schist and sand which are often in excess of the softened granitic material. Those deposits which have been at least partially water-sorted show more uniformity and greater concentrated quantities of white-burning clays. Several hundred pounds of feldspar were obtained from the old mica mines three miles north of Avon, Idaho. Heretofore, the feldspar has been thrown on the dump.

ENGINEERING FOUNDATION ELECTS A. D. FLINN TO NEWLY CREATED POST OF MANAGER

Election of Alfred D. Flinn as director of the Engineering Foundation, which is fostering organized industrial research on a nationwide scale, is announced by Charles F. Rand, chairman of the Foundation. Mr. Flinn is the first incumbent of the new post, created by the Foundation's governing board, composed of the Four Founder Societies.

ALFRED D. FLINN

Mr. Flinn will retire as Chairman of the Engineering Division of the National Research Council, a position which he has held since October, 1921, but will continue as secretary of the United Engineering Society in order that the Foundation may continue intimate relations with the Founder Societies. Mr. Flinn has been secretary of this society and of the Foundation since January, 1918, and is widely known by engineers throughout the country. He is a leading figure in engineering movements, including the plan to promote world unity, aid research and more thorough organization of the profession of engineering in this and other countries.

E. P. OGDEN WITH U. S. BUREAU OF MINES

Ellsworth P. Ogden, who was recently appointed Ceramic Engineer for the United States Bureau of Mines with headquarters at the Ceramic Experiment Station, Ohio State University, Columbus, Ohio, is an alumnus of Ohio State University of the Class of 1905. His engineering experience in the field of ceramics is good preparation for the service he has undertaken.

Mr. Ogden designed and built the Clay Craft Brick Company's plant at Shawnee, Ohio, in 1908, the original plant of the Murphysboro Paving Brick Company, Murphysboro, Illinois, in 1909, and the Harris Brick Company's plant, Zanesville, Ohio, in 1910. For three years he was factory engineer for one of the large terra cotta companies with duties at their five plants. Subsequently he has been engaged in the adaptation of producer gas to the firing of heavy clay wares, the manufacture of high voltage electrical porcelain, continuous tunnel kiln design and operation, floor and wall tile manufacture, vitreous enamel work. Mr. Ogden has been a member of the American Ceramic Society since 1906.

ELLSWORTH P. OGDEN

U. S. BUREAU OF MINES

Mineral Filler Investigation

In the course of the investigation of mineral fillers, being made by W. M. Weigel, mineral technologist, at the Southern experiment station of the Bureau of Mines, Birmingham-Tuscaloosa, Alabama, three special problems have been studied, *viz:* determination of grain size fillers, involving elutriation and microscopic measurement, followed by methods of calculation; the effect of heat treatment on the physical properties of white clays with respect to their use as fillers; and the utilization of Alabama flake graphite. The size of particle is a basic property of fillers upon which many of the other physical properties depend, consequently considerable work is being done in this direction. Work has been completed on the study of the effect of heat treatment on the physical properties of clays. The lubrication tests on graphite were satisfactory, while results of the moulding tests were negative. Experiments in the use of graphite as a remover of boiler scale were only partly satisfactory, being partly negative. A special investigation has been made of a series of clays from central Georgia and western Georgia with respect to their value as fillers.

U. S. BUREAU OF STANDARDS

Investigation of Vitreous China Bodies

The testing of specimens of vitreous china bodies made and fired in the factories has been completed. Specimens for the determination of porosity, transverse strength, compressive strength, and resistance to impact have been made from 11 commercial bodies fired at cones 6, 8, 10, 12, and 14. With the exception of the compression test, all of this work has been completed.

A meeting of the American Vitrified China Manufacturers Association was held at the Bureau on October 19 for the purpose of hearing a report on the work. All the results were explained and thoroughly discussed, and the data are now being compiled into a formal report.

Tests of Surface Condition of Molded Commercial Glass

A continuation of the work on glass containers with reference to their life in service has disclosed the fact that reheating the surfaces to the softening point retards penetration of moisture and reduces the tendency to disintegrate. This was shown to be the principal factor affecting the resistance of glass surfaces to disintegration rather than the degree of previous exposure of the surfaces to moisture. A study of the absorption of moisture at different temperatures of glasses of various composition is also being made.

Specifications for Biological Glass

The Bureau of Standards is collecting information from the Army, Navy, the Biological Survey, the Public Health Service, and manufacturers of biological products concerning the requirements of glass for this purpose and the desirability of preparing standard specifications covering the same. The Bureau has already assisted manufacturers of biological products in obtaining glass suitable for their use, but the requests have indicated a possible value for more complete specifications.

Bureau of Standards Conference with Vitrified China Manufacturers

A conference with the members of the American Vitrified China Manufacturers' Association was held at the Bureau of Standards on October 19 to discuss the results of the investigative work which the Bureau is doing in coöperation with these manufacturers. At this conference a report was presented by Mr. H. H. Sortwell, of the Bureau, giving the results of tests of china bodies burned in different parts of commercial kilns and also of tests of the same bodies burned to different temperatures in a laboratory kiln at the Bureau of Standards. This was an extensive piece of work as the bodies used by eleven different manufacturers were included and specimens burned to the different temperatures were tested for transverse strength, compressive strength, resistance to impact, and porosity.

In order to eliminate the personal factor in the preparation of the specimens, all of them were made by a representative of the Bureau of Standards, who went to each of the coöperating factories and prepared the test pieces to be burned at the factory.

The results were exceedingly instructive, showing the firing ranges of the different commercial bodies and the effect on strength and other properties of variations in the temperature attained in different parts of the commercial kilns. These results will aid materially in the preparation of specifications for hotel china and it is believed that this coöperative work will also assist the American manufacturers in maintaining the superiority of their product over that of foreign competitors.

A report of this investigation will be published in the near future.

SAGGER INVESTIGATION OF THE BUREAU OF STANDARDS

Within the last few weeks a large number of users of saggers have received from the Bureau of Standards a letter asking what sagger clays they are using. The purpose of this letter was to obtain information which, when properly coördinated, would constitute a survey of practically all the clays used in saggers throughout the United States. The same inquiry has been sent out to the members of the United States Potters Association, the Sanitary Potters Association, and the Tile Manufacturers Association, as well as to many of the manufacturers of electrical porcelain. There are unquestionably a considerable number of potters and tile manufacturers who are not included in the list and who, in consequence, have not received this letter. The Bureau would be glad to hear from all sagger users and invites those who have not received the letter to write voluntarily, giving the names of the clays that they are using, the localities from which they come and the names of producers or dealers from whom they are obtainable. The proportions in which the different clays are used in the sagger mix would be of interest, but it is not necessary that this should be stated.

A large number of responses to the letter of inquiry have been received and they show a very general appreciation of the importance of the investigation of problems relating to saggers as well as a wish, in practically every case, to contribute something to the work.

As a part of the sagger investigation, the Bureau is undertaking a study of the properties of practically all of the types of clays used in sagger making by American manufacturers. This in itself is an undertaking which will require considerable time, but the results of this part of the investigation will be made available as soon as this part of the work is completed. In order to obtain samples which would represent, as fairly as possible, commercial shipments and avoid the embarrassing questions that might otherwise arise as to the reliability of the results of the tests, the samples to be used in the investigation are being contributed by the users from their regular stocks. A large

number of samples, in two-hundred pound lots, are being shipped to the Bureau, freight prepaid, by purchasers, and the Bureau wishes to express its appreciation of this coöperation.

In order to forestall the inevitable question as to how far the Bureau will go in making public the results of tests of the various clays, it should be stated that the Bureau will follow its usual policy of withholding the names of brands and producers from publication. This appears to be necessary on account of the fact that the Bureau cannot control the future production of any grade of material and consequently the results of the tests made on any given clay, even assuming the sample to be representative of the clay at the time the tests were made, would be misleading if the brand were later to be improved or the reverse. The clays tested will be identified in the report by numbers, and the Bureau will be willing to give each user the numbers of the clays that he is using. Producers and dealers can obtain the numbers of their own clays with the understanding, of course, that this information shall not be published nor in any way used in advertising.

The study of sagger problems is no new thing and it is not to be expected that even the most important questions are going to be cleared up all at once, but it is the hope of the Bureau of Standards to contribute something within the next few months which will at least help to reduce the drain upon many manufacturers from the unsatisfactory service of saggers and possibly in some cases from expense occasioned by the use of clays requiring unnecessarily long hauls.

TWENTY-FIFTH ANNIVERSARY OF CERAMIC SCHOOL AT BUNZLAU, GERMANY

On November 4, 5, and 6, 1922, friends of the Ceramic School at Bunzlau gathered to celebrate the completion of twenty-five years of work by the school under the direction of Dr. W. Pukall. Dr. Felix Singer, a member of the AMERICAN CERAMIC SOCIETY, is on the Board of Directors of this school.

NATIONAL BRICK ASSOCIATIONS WILL MEET IN CLEVELAND IN 1923

The National Brick Manufacturers Association and the Common Brick Manufacturers Association will meet at Cleveland, Ohio, the week of Feb. 5, 1923. The fact that these organizations will gather at the same time and place augurs well for a record attendance, and Cleveland's central location is an added argument. The Hotel Winton will be headquarters for both conventions and all sessions and functions will occur there.

CALENDAR OF CONVENTIONS

American Association of Ice & Refrigeration—Washington, D. C., Probably March 1923.
American Association of Museums—Charleston, S. C., May, 1923.
AMERICAN CERAMIC SOCIETY—Pittsburgh, Pa., Feb. 12–16, 1923.
American Concrete Institute—Cincinnati, Ohio, Jan. 22–25, 1923.
American Engineering Standards Comm.—29 W. 39th St., New York City, Dec. 14, 1922.
American Face Brick Association—West Baden, Ind., Dec. 5–7, 1922.

American Foundrymen's Association—Date not determined.
American Institute of Mining and Metallurgical Engineers—New York City, Feb. 19–22, 1923.
American Malleable Castings Assn.—Cleveland, Ohio, Jan. 9–10, 1923.
American Metric Association—Boston, Mass., Dec. 30, 1922.
American Society of Mechanical Engineers—New York City, Dec. 4–8, 1922.
American Society of Refrigerating Engrs.—New York City, Dec. 4–6, 1922.
American Society for Testing Materials—Place not determined, June 1, 1923.
American Zinc Institute—St. Louis, Mo. or Atlantic City, N. J., First or second Monday in May, 1923.
Association of Scientific Apparatus Makers of the United States of America—Bureau of Standards, Washington, D. C., April 20, 1923.
Canadian National Clay Products Association and Western Ontario Clay Workers Association—Hamilton, Ont., January 24–26, 1923.
Chamber of Commerce of the U. S. A.—Place not determined, Week of May 7, 1923.
International Chamber of Commerce—Rome, Italy, Week of March 19, 1923.
Clay Products Association—Chicago, Ill., Third Tuesday each month.
Common Brick Mfrs. Association of America—Cleveland, Ohio, Week of Feb. 5, 1923.
Federated American Engineering Societies—Place not determined, Date not determined.
Manufacturing Chemists Association—New York City, June, 1923.
Mining and Metallurgical Society of America—New York City, December 7–13, 1922.
National Association of Mfrs. of Pressed and Blown Glassware—Pittsburgh, Pa., March 13, 1923.
National Association of Mfrs. of U. S.—New York City, Week of May 14, 1923.
National Association of Stove Mfrs.—Richmond, Va., May 9, 1923.
National Association of Window Glass Mfrs.—Place not determined, Date not determined.
National Association Builders Board of Control—Des Moines, Iowa, February, 1923.
National Bottle Mfrs. Association—Atlantic City, N. J., Last of April, 1923.
National Brick Mfrs. Association—Cleveland, Ohio, Week of Feb. 5, 1923.
National Canners Association—Atlantic City, N. J., Week of Jan. 22, 1923.
National Exposition of Power and Mechanical Engineering—New York City, December 7–13, 1922.
National Gas Association of America—Louisville, Ky., Spring, 1923.
National Jewelers Board of Trade—New York City, January 18, 1923.
National Paving Brick Mfrs. Assn.—Place not determined, Date not determined.
Sanitary Potters Association—Pittsburgh, Pa., Monthly Meetings.
Stoker Mfrs. Association—May or June, 1923, Place not determined.
Tile Manufacturers Credit Assn.—Beaver Falls, Pa., Quarterly Meetings.
U. S. Potters Association—Probably Washington, D. C., December 10, 1922.

NEW DEPARTMENT OF CERAMICS AND CLAY TESTING IS ORGANIZED

The University of Colorado has been given a small appropriation to start a Department of Ceramics and Clay Testing under the leadership of Professor R. D. George of the Geology Department. The other ceramic departments in the country will be interested in the welfare of the youngest addition to their family circle.

MEMBER OF THE AMERICAN CERAMIC SOCIETY WINS HONOR

W. H. Fulweiler, of Philadelphia, has been awarded the Grasselli Medal for his paper on "Chemical Problems in the Gas Industry," which he presented at the March 1922 meeting of the Society of Chemical Industry.

The Grasselli Medal is endowed by the Grasselli Chemical Company of Cleveland, Ohio, and is awarded by a Committee of the N. Y. Section of the Society of Chemical Industry for the paper presented during the previous year, that in the opinion of the Medal Committee offers the most useful suggestions in applied chemistry. The medal has been in existence for several years and has been awarded twice, the previous award being to Dr. Allen Rogers.

The medal was presented at a meeting of the Society of Chemical Industry held at the Chemists' Club, New York City, on October 20. Dr. H. S. Miner, Chief Chemist of the Welsbach Company and Vice-Chairman of the New York Section, made the presentation.

December, 1922 **The Journal of the American Ceramic Society** Vol. 5, No. 12

Published monthly by the American Ceramic Society
Publication Office, 211 Church St., Easton, Pa.
Editorial Office, 230 Lord Hall, Ohio State University, Columbus, Ohio
Advertising Department, 170 Roseville Ave., Newark, N. J.

Officers of the American Ceramic Society

President
F. H. Riddle, Champion Porcelain Co., Detroit, Mich.

Vice-President
E. W. Tillotson, Mellon Institute, Pittsburgh, Pa.

Treasurer
R. K. Hursh, University of Illinois, Urbana, Ill.

Secretary-Editor
Ross C. Purdy, 230 Lord Hall, Ohio State University, Columbus, Ohio

Assistant Secretary
Norah W. Binns

Assistant Editor
Emily C. Van Schoick

Trustees
R. H. Minton, General Ceramics Co., Metuchen, N. J.
F. K. Pence, Knowles, Taylor & Knowles, East Liverpool, Ohio
F. B. Ortman, Tropico Potteries Inc., Glendale, Cal.
R. M. Howe, Mellon Institute, Pittsburgh, Pa.
B. E. Salisbury, Onondaga Pottery, Syracuse, N. Y.

Standing Committees, 1922–1923.

Research
Wm. M. Clark, *Chairman*
E. W. Washburn
Paul E. Cox
A. V. Bleininger
and one from each Division

Geological Surveys
T. Poole Maynard, *Chairman*
Robert W. Jones
H. Ries
Joseph Keele
Hewitt Wilson

Data
To be selected by Divisions

Ceramic Education
To be appointed

Publications
R. H. Minton, *Chairman*
E. W. Tillotson
Chester H. Jones
H. F. Staley
R. C. Purdy

Sections and Divisions
J. B. Shaw, *Chairman*
Robert Back
Wm. E. Dornbach
Geo. P. Fackt
Major E. Gates
and Chairmen of Divisions

Standards
Walter E. Hull, *Chairman*
(a) **Definitions:**
A. S. Watts
M. F. Beecher
A. F. Greaves-Walker
(b) **Raw Materials:**
D. W. Ross
M. C. Booze
E. C. Hill
(c) **Standardization of Tests:**
All selected by Divisions
(d) **Standardization of Products:**
All selected by Divisions

Rules
T. A. Klinefelter, *Chairman*
R. L. Clare
A. S. Walden
B. T. Sweely
J. L. Crawford
and Chairmen of Divisional Committees on Rules

Papers and Program
R. D. Landrum, *Chairman*
R. C. Purdy
and Secretaries of Divisions

Membership
O. O. Bowman, 2nd, *Chairman*
R. F. Segsworth
Charles L. Sebring
Douglas F. Stevens
Frederick Stanger
Karl Türk
E. P. Poste
Gail R. Truman
Atholl McBean
and Chairmen of Divisional Committees on Membership

Entered as second-class matter, July 15, 1918, at the Post Office at Easton, Pa., under the Act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 16, 1918.
(Copyright 1922, American Ceramic Society)
Eight dollars a year. Single numbers, 75 cents.
(Foreign postage 36 cents additional)

AUTHOR INDEX TO BULLETIN

The reference number in parentheses refers to the *monthly* number of the *Bulletin;* the number following this is the page number. The letter D preceding reference number indicates that the article is a Discussion (D); the letter O means that article is Original (O).

A list of abbreviations used in the Index is found on page 381, *Ceramic Abstracts.*

VOLUME 1

Albery, D. F. Green staining of clayware, D (10) 237–38.
Amos, J. J. Items of cost frequently overlooked, D (12) 354, 358.
Aurien, G. Phys. defects in tank blocks, D (10) 242–46.

Bellamy, H. T. Small glass tank, D (10) 250–53; Water-cooling of glass tanks, D (10) 213; Why are open pots used in Europe and not in U. S.? D (12) 342.
Bleininger, A. V. Coöp. research on sagger mixt. and manuf., D (7) 105; The AMER. CERAM. Soc. and the pottery industry, E (2) 28.
Bole, G. A. New developments in oxychloride stucco and flooring, D (8) 160.
Bowman, O. O., 2nd. Coll. on feldspar, D (11) 287.
Brown, W. F. Fine or coarse-ground mixts. for checker brick in glass fur., D (12) 347; Glass containers, D (12) 345–46; Phys. defects in tank blocks, D (10) 240, 245–47; Small glass tank, D (10) 252–53; Water-cooling of glass tanks, D (11) 312.
Buckingham, A. W. Data on opern. of continuous tunnel kiln at plant of A. C. Spark Plug Co., D (9) 189–90.

Carruthers, J. L. Notes on shivering of terra cotta, D (11) 301, 303; Use of forced draft for terra cotta kilns, D (10) 223–24.
Child, J. L. Items of cost frequently overlooked, D (12) 357.
Clare, R. L. Data on viscosity of Ind. clay slip with electrolytes in regard to casting of terra cotta, D (11) 303.
Cox, P. E. Extension work, O (6) 45; Fire clays of Iowa, O (9) 187; Painting in underglaze colors on biscuit, D (7) 113.
Cruikshank, J. W. Best type of crowns to be used over glass tanks, D (12) 339.

Dailey, E. W. Items of cost frequently overlooked, D (12) 355–58.
Danielson, R. R. Microscopic study of ground-coat and cover-coat enamel reactions, D (8) 161; Modification of mol. formula for glaze and enamel calcn., D (10) 235; Wet process enamels for cast iron, D (11) 308, 309.
Darby, G. M. Coll. on feldspar, D (11) 285–86.
Davis, N. B. Coll. on feldspar, D (7) 92.
Dixon, H. L. Handling, storing and setting of glass pots, D (10) 247–48; Opern. of leers, D (10) 250; Phys. defects in tank blocks, D (10) 242–43, 245–47; Small glass tank D (10) 251–53.
Dornbach, W. E. Note on refrac. eng., O (6) 43.

Endell, K. Influence of grind and burn on charac. of silica brick, D (9) 187; Refrac. for oil-burning fur., D (10) 231; Silica brick, D (12) 359; Testing of silica brick, D (9) 181.

Fenner, C. N. Products of calcination of flint and chalcedony, D (11) 298.
Fessler, A. H. See Gilmore, R. B.
Fisse, J. H. Phys. defects in tank blocks, D (10) 240–41, 245.
Forsyth, J. H. Fine or coarse-ground mixts. for checker brick in glass fur., D (12) 347; Glass containers, D (12) 344; Handling, storing and setting of glass pots, D (10) 248–49; Water-cooling of glass tanks, D (11) 312; Why are open pots used in Europe and not in U. S.? D (12) 341–42.
Franzheim, C. M. Coll. on feldspar, D (11) 202; Feldspar, D (7) 96.
Fulton, C. E. Fine or coarse-ground mixts. for checker brick in glass fur., D (12) 347; Glass containers, D (12) 345.

Gates, W. D. Use of forced draft for terra cotta kilns, D (10) 223–24.
Geiger, C. F. Refrac. for oil-burning fur., D (10) 232.
Gelstharp, F. Notes on diagnosing causes of cords in glass, D (7) 112.
Gilmore, R. B. and Fessler, A. H. Acct. of invest. of some Ga. clays and bauxites, O (9) 193.
Goodman, M. H. Glass containers, D (12) 345.
Goodwin, H. Data on opern. of continuous tunnel kiln at plant of A. C. Spark Plug Co., D (9) 188; Coöp. research on sagger mix. and mfg., D (7) 106–8.
Grafton, C. O. Why are open pots used in Europe and not in U. S.? D (12) 342.
Grafton, C. V. Phys. defects in tank blocks, D (10) 241; Water-cooling of glass tanks, D (11) 311.
Greaves-Walker, A. F. Adaptability of gas-fired compartment kiln for burning of clay products, D (6) 53; Influence of grind and burn on charac. of silica brick, D (9) 185–7; Note on refrac. eng., D (6) 45; Refrac. for oil-burning fur., D (10) 230–31, 233; Testing of silica brick, D (9) 180–183.
Greenough, M. B. Items of cost frequently overlooked, D (12) 356, 358.
Greenwood, G. W. Prophetic cost accounting, O (1) 17.
Greer. Items of cost frequently overlooked, D (12) 354.

Hansen, J. E. Modification of mol. formula for glaze and enamel calcn., D (10) 235, 237; Wet process enamels for cast iron, D (11) 305.
Hardinge, H. Coll. on feldspar, D (7) 87; (8) 144, 145.
Harrop, C. B. Adaptability of gas-fired compartment kiln for burning of clay products, D (6) 52; Data on opern. of continuous tunnel kiln at plant of A. C. Spark Plug Co., D (9) 190.
Harvey, F. A. Influence of grind and burn on charac. of silica brick, D (9) 184–85; Testing of silica brick, D (9) 180–82.
Helser, P. D. Data on opern. of continuous tunnel kiln at plant of A. C. Spark Plug Co., D (9) 189–190.
Herbert, W. H. Items of cost frequently overlooked, D (12) 352–53.
Herzog, J. S. Evolution and development of glass house equipment, O (8) 124.
Hess, H. W. Why are open pots used in Europe and not in U. S.? D (12) 341–42.
Hill, C. W. Notes on green staining of clay ware, O (6) 51; Expt. on fire cracking of terra cotta, D (10) 225, 228; Green staining of clayware, D (10) 238; Notes on shivering of terra cotta, D (11) 302.

Hill, E. C. Notes on shivering of terra cotta, D (11) 301; Expts. on fire cracking of terra cotta, D (10) 226, 227, 229; Use of forced draft for terra cotta kilns, D (10) 224.
Hostetter, J. C. Abstracting and pubg. data of value for glass-research labs., D (12) 339; Best type of crowns to be used over glass tanks, D (12) 339; Fine or coarse-ground mixts. for checker brick in glass fur., D (12) 347; Glass containers, D (12) 343–46; Opern. of leers, D (10) 249, 250; Phys. defects in tank blocks, D (10) 244, 245; Small glass tank, D (10) 251; Why are open pots used in Europe and not in U. S.? D (12) 340, 342.
Hottinger, A. F. Expts. on fire-cracking of terra cotta, D (10) 225, 227, 229; Green staining of clayware, D (10) 237, 238; Notes on shivering of terra cotta, D (11) 301; Use of forced draft for terra cotta kilns, D (10) 222.
Houser, A. T. Phys. defects in tank blocks, D (10) 243.
Howe, R. M. Refrac. for oil-burning fur., D (10) 231; Influence of grind and burn on char. of silica brick, D (9) 184–86; Testing of silica brick, D (9) 183.
Hull, W. A. Influence of grind and burn on charac. of silica brick, D (9) 185.
Hunt, F. S. Coöp. research on sagger mixt. and mfg., D (7) 103.

Insley, H. Influence of ht. on microscopic properties of silica in different mineral forms, D (12) 348.

Keplinger, R. B. Laminations, discussion of cause and cure, D (7) 109.
Klein, A. A. Data on opern. of continuous tunnel kiln at plant of A. C. Spark Plug Co., D (9) 188; Coll. on feldspar, D (7) 79.
Klinefelter, T. A. Use of forced draft for terra cotta kilns, D (10) 223.
Knothe, W. J. Best type of crowns to be used over glass tanks, D (12) 339.

Ladoo, R. B. Coll. on feldspar, D (7) 79–84, 97–101; (8) 136; (11) 279; Derry feldspar quarry, D (8) 146.
Laird, J. S. Refrac. for oil-burning fur., D (10) 233.
Landers, W. H. Coll. on feldspar, D (11) 271, 286, 291, 294.
Landrum, R. D. Modification of mol. formula for glaze and enamel calcns., D (10) 235.
Langenbeck, K. The *Bulletin*, a forum of mutual help, E (6) 27.
Langworthy, H. S. Items of cost frequently overlooked, D (12) 352–53.
Lindemann, W. C. Wet process enamels for cast iron, D (11) 305.
Loomis, G. A. Phys. defects in tank blocks, D (10) 239, 240, 243.

McDowell, J. S. Testing of silica brick, D (9) 181–82; Influence of grind and burn on charac. of silica brick, D (9) 184, 185–87.
McDowell, S. J. Data on opern. of continuous tunnel kiln at plant of A. C. Spark Plug Co., D (9) 188.
McIntyre, W. A. Phys. defects in tank blocks, D (6) 54.

MacMichael, P. S. Use of forced draft for terra cotta kilns, D (10) 224.
Manson, M. E. Wet process enamels for cast iron, D (11) 307.
Mathiason, O. E. Expts. on fire cracking of terra cotta, D (10) 226.
Miller, A. M. Fire clays of E. coalfield of Ky., D (8) 161.
Minton, R. H. Adaptability of gas-fired kiln for burning of clay products, D (7) 107.
Moore, C. R. Coll. on feldspar, D (11) 288.

Ogale, G. P. Glass indus. in India, O (11) 295.
Onan. Small glass tank, D (10) 253.

Ortman, F. B. Expts. on fire cracking of terra cotta, D (10) 226.
Owens, F. T. Items of cost frequently overlooked, O (2) 48.

Parmelee, C. W. Refrac. for oil-burning fur., D (10) 231, 233.
Payne, A. R. Glass containers, D (12) 345; Opern. of leers, D (10) 249, 250; Water-cooling of glass tanks, D (11) 310.
Pike, R. D. New developments in oxychloride stucco and flooring, D (8) 157.
Poste, E. P. Effect of sources of pig iron upon enameling of cast iron, D (12) 360; Microscopic study of ground-coat and cover-coat enamel reactions, D (8) 162.
Potts, A. Items of cost frequently overlooked, D (12) 353–54.
Purdy, R. C. Coll. on feldspar, D (7) 94; Theory of plasticity and possible commercial application, D (8) 147.

Radcliffe, B. S. Expts. on fire cracking of terra cotta, D (10) 228; Use of forced draft for terra cotta kilns, D (10) 222, 224.
Rhead, F. H. Amer. Ceram. Soc. exhibition, O (5) 10; Italian majolica process and painting over tin enamels, O (9) 177; Kiln manipulation in reln. to school and studio pottery, P (8) 131.
Ries, H. Derry feldspar quarry, D (8) 146.
Robson, J. T. Influence of ht. on microscopic properties of silica in different mineral forms, D (12) 348.
Rodgers, J. P. Coll. on feldspar, D (7) 80–83.
Root, E. Need for organization in scientific research, O (1) 8.
Ross, D. W. Testing of silica brick, D (9) 181-83.

Schramm, E. Data on opern. of continuous tunnel kiln at plant of A. C. Spark Plug Co., D (9) 188; Coll. on feldspar, D (7) 92.
Schurecht, H. G. New developments in oxychloride stucco and flooring, D (8) 160; Note on reln. of structure of clay grains to plasticity of clays, P (8) 153.
Seaton, M. Y. New developments in oxychloride stucco and flooring, D (8) 155.
Sebring, C. L. Coöp. research on sagger mixt. and mfg., D (7) 103.
Segsworth, R. F. Coll. on feldspar, D (7) 89.
Sheffield, A. H. Expts. on fire cracking of terra cotta, D (10), 227.
Sladek, G. E. Coll. on feldspar, D (7) 79.
Smith, N. G. Coll. on feldspar, D (7) 83.
Sortwell, H. H. Field of porcelain glazes maturing between cones 17¾ and 20, D (9) 191.
Sproat, I. E. Coöp. research on sagger mixt. and mfg., D (7) 104.
Spurrier, H. Feldspar, D (7) 79, 84, 91, 95.
Staley, H. F. Comparative tests of Amer. and foreign tableware, D (9) 193; Effect of sources of pig iron upon enameling of cast iron, D (12) 364; Modification of mol. formula for glaze and enamel calcns., D (10) 235.
Staudt, A. Coöp. research on sagger mixt. and mfg., D (7) 105; Data on opern. of continuous tunnel kiln at plant of A. C. Spark Plug Co., D (9) 187.
Stern, N. W. Coll. on feldspar, D (8) 134.
Stevens, D. F. Items of cost frequently overlooked, D (12) 350–56.
Stockstrom, A. New type of gas-fired vitreous enameling fur., D (10) 238.
Stout, V. A. Coll. on feldspar, D (8) 137, 141; Correction, D (11) 269.
Sweely, B. T. Microscopic study of ground-coat and cover-coat enamel reactions, D (7) 112.

Tefft, C. F. Items of cost frequently overlooked, D (12) 355, 359.
Townsend, E. Coll. on feldspar, D (8) 140.
Treischel, C. C. Data on opern. of continuous tunnel kiln at plant of A. C. Spark Plug Co., D (9) 191; Coll. on feldspar, D (7) 96; Coöp.

research on sagger mixt. and mfg., D (7) 101–105.
Turner, E. W. Coll. on feldspar, D (11) 283.

Wainford, R. H. Feldspar, D (7) 84.
Washburn, E. W. Products of calcination of flint and chalcedony, D (11) 300.
Watson, H. L. Small glass tank, D (10) 251–53.
Williams, A. E. Glass containers, D (12) 343–46; Water-cooling of glass tanks, D (11) 312.
Woodall, W. C. Acct. of invest. of some Ga. clays and bauxites, D (11) 304.
Wright, J. W. Phys. defects in tank blocks, D (10) 243; Small glass tank, D (10), 251–53; Water-cooling of glass tanks, D (11) 313; Why are open pots used in Europe and not in U. S.? D (12) 341–42.

Yung, W. A. Glass containers, D (12) 344, 345; Phys. defects in tank blocks, D (10) 244; Water cooling of glass tanks, D (11) 310.

Zopfi, A. S. Fine or coarse-ground mixts. for checker brick in glass fur., D (12) 346–47; Phys. defects in tank blocks, D (10) 240, 241.

SUBJECT INDEX TO BULLETIN

Abstracting and publishing data of value for glass-research labs., D (12) 339.
Amer. Ceram. Soc. Exhibition, (1) 10.

Bauxites and clays, Georgia, invest. of some, (5) 193, D (11) 304.
Blocks, tank, phys. defects of, D (2) 54, D (10) 239.
Brick, checker, fine or coarse-ground mixts. for, in glass fur., D (12) 346.
silica, D (12) 359.

Cast iron, wet process enamels for, D (11) 305.
Chalcedony, and flint, products of the calcination of, D (11) 298.
Clay ware, green staining of, O (2) 51, D (10) 237.
Clays and bauxites, Georgia, invest. of some, (5) 193, D (11) 304.
fire, of the E. coalfield of Ky., D (4) 161.
of Iowa, (5) 187.
plasticity of, and colloid phenomena, D (4) 147.
of, note on the relation of structure of clay grains to, (4) 153.
of, theory of, D (4) 147.
Colloid phenomena and plasticity of clays, D (4) 147.
Cords in glass, diagnosing causes of, D (3) 112.
Cost accounting, prophetic, (1) 17.
items frequently overlooked, O (2) 48, D (12) 350.

Derry feldspar quarry, D (4) 146.
Draft, forced, for terra cotta kilns, use of, D (10) 222.

Editorials
Action of refractories under load conditions at high temps., (4) 121.
Amer. Ceram. Soc. excursion to England and Europe, (1) 7.
The Bulletin, a forum of mutual help, (2) 27.
Chem. Exposition Speakers, (5) 175.
Conventions, (4) 117.
Individualism vs. Coöperation, (12) 337.
New Jersey Ceram. Research Station Building dedicated, (3) 63.
Our Budget for 1922, (2) 31.
Our Twenty-fifth Anniversary Convention, (10) 219.
Personal versus corporation members in the Amer. Ceram. Soc., (1) 15.
Frank H. Riddle: President of the Amer. Ceram. Soc., (1) 1.
Service and cost. A chat with the Secretary, (4) 119.
Survey of simplification needs to be conducted by Amer. Engineering Standards Comm., (4) 122.
Edwin W. Tillotson, Jr., (4) 120.
The Amer. Ceram. Soc. and the pottery industry, (2) 28.
The Art Division. Its activities and its possibilities, (2) 29.
The value of the abstract service rendered by the Amer. Ceram. Soc., (5) 171.
The value of discussions, (3) 67, (11) 267.
The "What For" of the Amer. Ceram. Soc., (5) 172.
Two notable events mark progress in ceram. engineering. Edward Orton, Jr., made Doctor of Science, (3) 63.
Dr. Edward W. Washburn. A sketch and a tribute, (3) 57.
Why it is important that corporations support the Amer. Ceram. Soc., (1) 3.
Enamel and glass calcns., a modification of the mol. formula for, D (10) 235.
reactions, ground coat and cover coat, microscopic study of, D (3) 112, D (4) 161.
Enameling fur., a new type of gas-fired vitreous, D (10) 238.
of cast-iron, effect of sources of pig iron upon D (12) 360.
Enamels for cast iron, wet process, D (11) 305.
tins, painting over, (5) 177.
Extension work in pottery, (2) 45.

Feldspar and feldspar deposits, colloquium on D (3) 78.
and feldspar grinding, colloquium on, D (4) 133.
colloquium on, (11) 269.
quarry, Derry, D (4) 146.
stand. specif. for, D (11) 271.
Fineness of grind, method and app. for quickly detg., D (11) 283.
Fire clays. See Clays.
cracking of terra cotta, some expts. on, D (10) 225.
Flint and chalcedony, products of the calcination of, D (11) 298.
Flooring and stucco, oxychloride, new developments in, D (4) 155.
Furnace, gas-fired vitreous enameling, a new type of, D (10) 238.
Furnaces, oil-burning, refrac. for, D (10) 229.

Gas-fired vitreous enameling fur., a new type of, D (10) 238.
Georgia clays and bauxites, invest. of some, O (5) 193, D (11) 304.
Glass containers, D (12) 343.
cords in, diagnosing causes of, D (3) 112.
furnaces, fine or coarse-ground mixts. for checker brick in, D (12) 346.
house equipment, evolution and development of, (4) 124.
indus. in India, (11) 295.
pots, the handling, storing and setting of, D (10) 247.
-research, abstracting and publishing data of value for labs. of, D (12) 339.
tank, a small, D (10) 250.
tanks, best type of crown to be used over, D (12) 339.
water cooling of, D (11) 310.
Glaze and enamel calcns., a modification of the mol. formula for, D (10) 235.
Glazes, porcelain, maturing between cones 17 and 20, D (5) 191.
Green staining of clay ware, O (2) 51, D (10) 237.

India, glass industry in, (11) 295.
Indiana clay slips, viscosity of, with electrolytes in regard to the casting of terra cotta, D (11) 303.
Iowa, fire clays of, (5) 187.
Iron, pig, effect of sources of, on enameling of cast iron, D (12) 360.

Kentucky, fire clays of the E. coalfield, D (4) 161.
Kiln, continuous tunnel, at the plant of the A. C. Spark Plug Co., Flint, Mich., D (5) 187.
gas fired compartment, adaptability of, for burning clay products, D (2) 52, D (3) 107.
manipulation in relation to school and studio pottery, (4) 132.
Kilns, terra cotta, use of forced draft for, D (10) 222.

Laminations, discussion of cause and cure, D (3) 109.
Leers, operation of, D (10) 249.

Majolica process, the Italian, (5) 177.
Microscopic properties of silica minerals, the influence of heat on, D (12) 348.
study of ground coat and cover coat enamel reactions, D (3) 112, D (4) 161.

Oxychloride stucco and flooring, new developments in, D (4) 155.

Painting in underglaze colors on the biscuit, D (3) 113.
Plasticity of clays and colloid phenomena, D (4) 147.
of clays, note on the relation of the structure of clay grains to, (4) 153.
theory of, and possible commercial application, D (4) 147.
Porcelain glazes maturing between cones 17 and 20, D (5) 191.
Pots, glass, the handling, storing and setting of, D (10) 247.
open, are used in Europe and not in the U. S., why? D (12) 340.

Refractories engineering, note on, (2) 43.
for oil-burning fur., D (10) 229.
Research on sagger mixts. and manuf., cooperative, (3) 101.
scientific, the need for organization in, (1) 8.

Sagger mixts. and manuf., coöperative research on, (3) 101.
Shivering of terra cotta, notes on, D (11) 301.
Silica brick, D (12) 359.
brick, influence of grind and burn on the charac. of, D (5) 184.
testing of, D (5) 180.
minerals, microscopic properties of, the influence of heat on, D (12) 348.
Stucco and flooring, oxychloride, new developments in, D (4) 155.

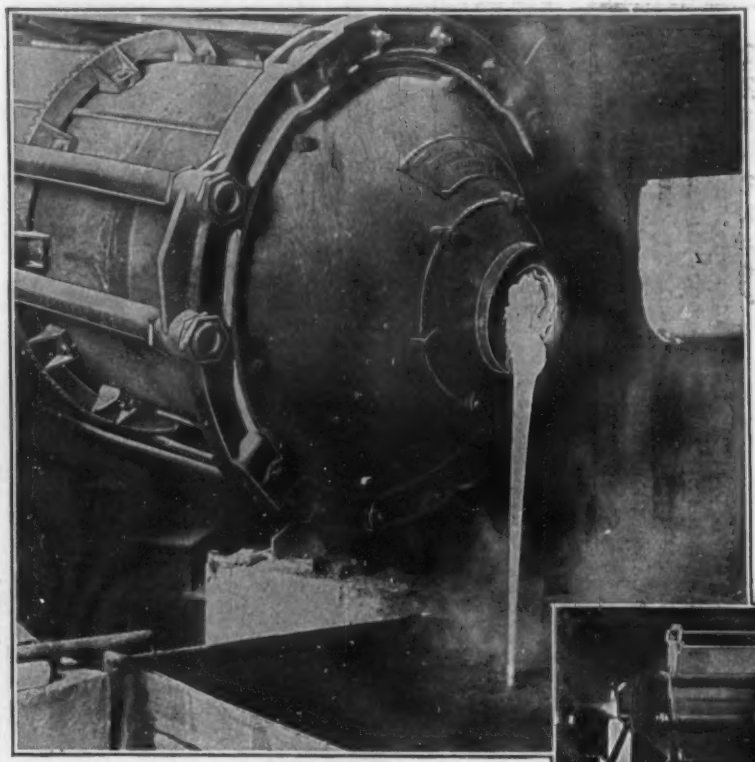
Tableware, comparative tests of Amer. and foreign, D (5) 193.
Tank blocks, phys. defects of, D (2) 54, D (10) 239.
glass, a small, D (10) 250.
Tanks, glass, best type of crown to be used over, D (12) 339.
water cooling of, D (11) 310.
Terra cotta, casting of, viscosity of Indiana clay slip in regard to the casting of, D (11) 303.
fire cracking of, some expts. on, D (10) 225.
shivering of, notes on, D (11) 301.
Tin enamels, painting over, (5) 177.

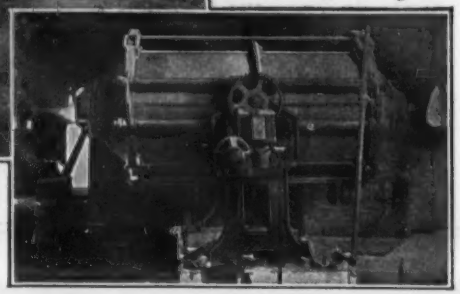
Underglaze colors, painting on the biscuit, D (3) 113.

Mfg. Co., Beaver Falls, Pa.

12–21

U. S. SMELTING FURNACE CO.
BELLEVILLE, ILLINOIS





These illustrations made from photographs taken in the plant of Ingram-Richardson Mfg. Co., Beaver Falls, Pa.

12–21

"Our U. S. Enamel Furnaces Increase Output 25% per day at a Saving of 50% in Fuel Cost."

Ingram-Richardson Mfg. Company claim those remarkable results for their U. S. Enamel Furnaces. With four U. S. Furnaces operating at their plants at Frankfort, Indiana, and Beaver Falls, Pa., they are saving thousands of dollars yearly in fuel and labor.

Their white and colored enamels are smelted in quick time, with low loss. The work is easy and sure. The Furnace is under perfect scientific control. The melting process is visible. The Furnace rotates while melting and tilts when pouring. Linings last longer and cost less.

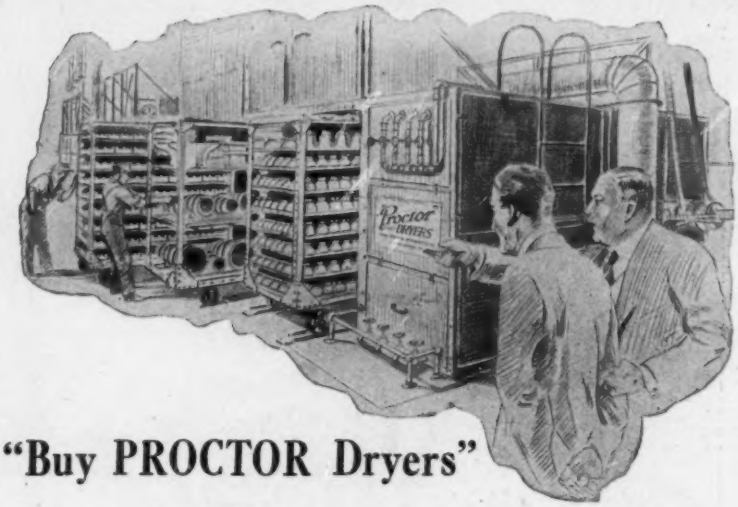
The U. S. Enamel Furnace is saving money over the old brick smelter in the Ingram-Richardson Mfg. Company plant. It will do the same for you.

Let the U. S. Furnace melt your enamel.

Write for specifications and prices on 60 lb., 150 lb., 400 lb., 750 lb., and 1200 lb. Enamel Furnaces. We will send photographs and list of users where furnaces are in operation.

THE
U. S. SMELTING FURNACE CO.
BELLEVILLE, ILLINOIS

(When writing to advertisers, please mention the JOURNAL)



"Buy PROCTOR Dryers"

"These machines are giving perfect drying on all types of porcelain—

"It's really surprising what improvement they've made over our old dry-rooms. The time they save is directly responsible for a much quicker production-turnover. For instance, our 80 lb. to 120 lb. insulators used to take 13 to 14 days to dry—now they're dried in 48 to 60 hours.

"Our loss used to run as high as 15%—now it's down to 3% or 4% because of correct drying.

"We now use only about half the floor-space, fewer workmen and greatly less steam—that's saving money.

"But what is best of all, our drying is systematic and smooth-running; the kilns are never kept waiting; we wouldn't be without PROCTOR DRYERS."

This is a typical experience with PROCTOR DRYERS. Let us acquaint you with their profitable advantages in drying any Ceramic Product.

PROCTOR & SCHWARTZ, INC.
PHILADELPHIA, PA.

"Proctor" DRYERS

BUYERS' GUIDE

Air Compressors
General Electric Co.

Alumina (Hydrate and Calcined)
Pennsylvania Salt Mfg. Co.

Auger Machines
Chambers Brothers Co.
Manufacturers Equipment Co.

Automatic Cutters
Chambers Brothers Co.

Automatic Stove Rooms
Philadelphia Drying Mch. Co.

Ball Mills
Hardinge Co.
Mueller Machine Co., Inc.

Bituminous Coal
Seaboard Fuel Corp.

Boilers
Nashville Industrial Corp.

Brick Making Machinery
Chambers Brothers Co.

Caustic Soda
Pennsylvania Salt Mfg. Co.

Ceramic Chemicals
Drakenfeld Co., B. F.
Harshaw, Fuller and Goodwin Co.
Paper Makers Importing Co., (Inc.)
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Ceramic Plant Equipment
Chambers Brothers Co.
Manufacturers Equipment Co.
Mueller Machine Co., Inc.
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.

Clay (Abrasives)
Old Hickory Clay & Talc Co.

Clay (Ball)
Old Hickory Clay & Talc Co.
Potters Supply Co., The
United Clay Mines Corp.

Clay (China)
Edgar Brothers Co.
Drakenfeld and Co., B. F.
Old Hickory Clay & Talc Co.
Paper Makers Importing Co., (Inc.)
Roessler & Hasslacher Chemical Co.
United Clay Mines Corp.

Clay (Electrical —Porcelain)
Edgar Brothers Co.
Old Hickory Clay & Talc Co.
Paper Makers Importing Co., (Inc.)
United Clay Mines Corp.

Clay (Enamel)
Edgar Brothers Co.
Old Hickory Clay & Talc Co.
The Vitro Manufacturing Co.
United Clay Mines Corp.

Clay (Fire)
Edgar Brothers Co.
Old Hickory Clay & Talc Co.
Paper Makers Importing Co., (Inc.)
United Clay Mines Corp.

Clay (Potters)
Old Hickory Clay & Talc Co.
United Clay Mines Corp.

Clay (Sagger)
Edgar Brothers Co.
Old Hickory Clay & Talc Co.
Paper Makers Importing Co., (Inc.)
Potters Supply Co., The
United Clay Mines Corp.

Clay Handling Machinery
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Mueller Machine Co., Inc.

Clay Miners
Edgar Brothers Co.
Old Hickory Clay & Talc Co.
United Clay Mines Corp.

Clay (Wall Tile)
Old Hickory Clay & Talc Co.

Clay Washing Machinery
Mueller Machine Co., Inc.

Clay Working Machinery
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Mueller Machine Co., Inc.

Coal-(Bituminous)—
Seaboard Fuel Corp.

Colors
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.
Wuerz, Eugene

Conditioning Machinery
Philadelphia Drying Machinery Co.

Conical Mills
Hardinge Co.

Controllers
General Electric Co.

Conveyors (Clay, Sand, Brick, etc.)
Hadfield-Penfield Steel Co.
Philadelphia Drying Machinery Co.
Manufacturers Equipment Co.
Mueller Machine Co., Inc.

Controllers (Automatic Temperatures)
Charles Engelhard, Inc.

Cornwall Stone
Pennsylvania Pulverizing Co.
United Clay Mines Corp.

Crushers
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Hardinge Co.
Manufacturers Equipment Co.
Mueller Machine Co., Inc.

Decorating Supplies
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Disintegrators
Chambers Brothers Co
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Mueller Machine Co., Inc.

Doors (Kiln-Dryer)
Manufacturers Equipment Co.

Dryers (China Ware—Porcelain)
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.
Russell Engineering Co.

Dryers (Radiated Heat)
Manufacturers Equipment Co.

Drying Machinery
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.
Manufacturers Equipment Co.

Electrical Instruments
Brown Instrument Co.
Charles Engelhard
Wilson-Maeulen Co.

Electrical Porcelain Machinery
Mueller Machine Co., Inc.

Enameling Equipment, Complete
Chicago Vitreous Enamel Product Co.
The Porcelain Enamel & Mfg. Co

Enameling Furnaces
Chicago Vitreous Enamel Product Co.
General Electric Co.
The Porcelain Enamel & Mfg. Co
U. S. Smelting Furnace Co.

Feldspar and Flint
Ground to
98% passing 200 mesh
91% passing 300 mesh

Grinding Feldspar to a fineness of less than 2% on 200 mesh is no unusual record, but when it is realized that the Hardinge System produces such a product and at the same time is continuous in operation, delivering a uniformly fine product, no wonder these results are remarkable and indicate a marked advance in the art of pulverizing.

Hardinge Company, Incorporated,
120 Broadway, New York, N. Y.

Hardinge Conical Mills

BUYERS' GUIDE (continued)

Enameling Furnaces (Electric)
General Electric Co.

Enameling Muffles
General Electric Co.
Parker-Russell Mining & Mfg. Co.

Enameling, Practical Service
Chicago Vitreous Enamel Product Co.
The Porcelain Enamel & Mfg. Co.

Enamels, Porcelain
Chicago Vitreous Enamel Product Co.
The Porcelain Enamel & Mfg. Co.
The Vitro Manufacturing Co.

Engineering Service
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.

Equipment (Electrical)
General Electric Co.

Equipment (used)
Nashville Industrial
Mueller Machine Co., Inc.
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.
Russell Engineering Co.

Engines
Nashville Industrial Corp.

Extruding Machines (Lab. Use)
Chambers Brothers Co.

Feldspar
Drakenfeld and Co., B. F.
Feldspars Limited
Golding-Keene Co.
Harshaw, Fuller and Goodwin Co.
O'Brien and Fowler
Old Hickory Clay & Talc Co.
Pennsylvania Pulverizing Co.
Roessler & Hasslacher Chemical Co.
United Clay Mines Corp.

Filtering Machinery
Mueller Machine Co., Inc.

Fire Brick
Parker-Russell Mining & Mfg. Co.

Flint
Golding-Keene Co.
Pennsylvania Pulverizing Co.

Fuel
Seaboard Fuel Corp.

Furnaces
Chicago Vitreous Enamel Product Co.
Parker-Russell Mining & Mfg. Co.
The Porcelain Enamel & Mfg. Co.
The Surface Combustion Co.
U. S. Smelting Furnace Co.

Furnaces (Electrical)
General Electric Co.

Glazes and Enamels
Chicago Vitreous Enamel Product Co.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Manufacturing Co.

Gold
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.

Impervite (Refractory and Hard Porcelain)
Charles Engelhard, Inc.

Iron (Enameling)
United Alloy Steel Corp.

Jiggers
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

Kaolin
Edgar Plastic Kaolin Co.
Harshaw, Fuller and Goodwin Co.
Old Hickory Clay & Talc Co.
Roessler & Hasslacher Chemical Co.
United Clay Mines Corp.

Kryolith
Pennsylvania Salt Mfg. Co.

Laboratory Equipment
Nashville Industrial Corp.

Metals (Porcelain Enameling)
United Alloy Steel Corp.

Mills *(See under Ball Mills)*
(See under Pebble Mills)

Minerals
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
The Vitro Manufacturing Co.

Mixing Machines
Chambers Brothers Co.

Muriatic Acid
Harshaw, Fuller and Goodwin Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.

Operators (Coal)
Seaboard Fuel Corp.

Oxides
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Paper Makers Importing Co., (Inc.)
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.
The Vitro Manufacturing Co.

Pans (Wet and Dry)
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Mueller Machine Co., Inc.

Paris White
Potters Supply Co., The

Pebble Mills
Hadfield-Penfield Steel Co.
Hardinge Co.
Mueller Machine Co., Inc.

Pins
Potters Supply Co., The

Placing Sand
Pennsylvania Pulverizing Co.

Plate Feeders
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.

Porcelain Enameling Service, Practical
Chicago Vitreous Enamel Co.
The Porcelain Enamel & Mfg. Co.

Porcelain Enamels
Chicago Vitreous Enamel Product Co
The Porcelain Enamel & Mfg. Co.
The Vitro Manufacturing Co.

Pottery Machinery
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Mueller Machine Co., Inc.

Producer Gas Burning Systems
Manufacturers Equipment Co.

Pug Mills
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.

Pulverizing Machinery
Hadfield-Penfield Steel Co.
Hardinge Co.
Manufacturers Equipment Co.
Mueller Machine Co., Inc.

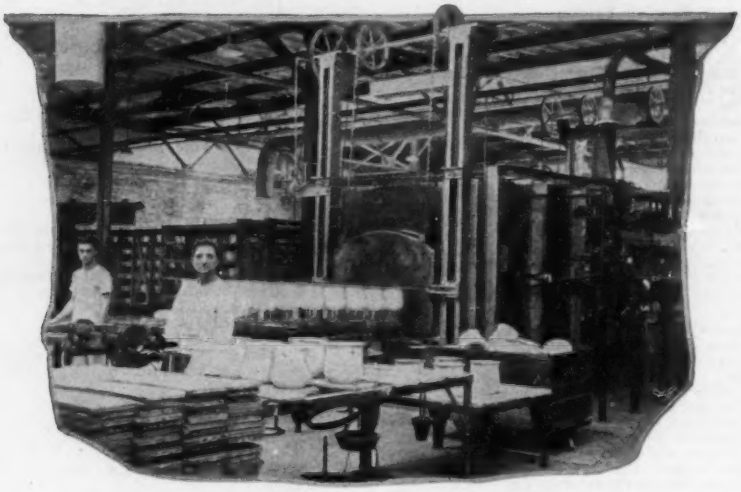
Pulverizing Mills
Hadfield-Penfield Steel Co.
Hardinge Co.
Mueller Machine Co., Inc.

Pumps
Mueller Machine Co., Inc.

Pyrometers (Indicating)
Brown Instrument Co.
Charles Engelhard, Inc.
Wilson-Maeulen Co., Inc.

Pyrometers (Recording)
Brown Instrument Co.
Charles Engelhard, Inc.
Wilson-Maeulen Co., Inc.

Now it's done electrically



Vitreous enameling has been simplified and improved by the use of electric furnaces equipped with heating units of G-E Direct-Heat design.

Unmuffled units within the furnace chamber radiate smokeless, flameless heat direct to the charge—with an intensity so perfectly applied and accurately controlled that the maximum speed and highest quality of vitreous enameling are obtained; and product spoilage is eliminated.

Vitreous enameling can be done by electric heat at less cost than with any other type of furnace. Our Heating Specialists are at your service.

General Electric Company

General Office Schenectady, N.Y.

Sales Offices in all large cities

39-82

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE (continued)

Pyrometer Tubes (Refractory and Hard Porcelain)
Brown Instrument Co.
Charles Engelhard, Inc.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co

Quartz
Old Hickory Clay & Talc Co.

Recording Instruments
Brown Instrument Co.
Charles Engelhard, Inc.
Wilson-Maeulen Co., Inc.

Refractory Materials
Parker-Russell Mining & Mfg. Co.

Regulators (Automatic Temperatures)
Brown Instrument Co.
Charles Engelhard, Inc.
Wilson-Maeulen Co., Inc.

Sagger Presses
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

Shippers (Coal)
Seaboard Fuel Corp.

Silica Brick
Parker-Russell Mining & Mfg. Co.

Silex Lining
Hardinge Co.

Selenite of Sodium
Drakenfeld and Co., B. F.
Vitro Mfg. Co.

Smelters
Parker-Russell Mining & Mfg. Co.
The Surface Combustion Co
U. S. Smelting Furnace Co.

Spar
Feldspars Limited
Golding-Keene Co.
Pennsylvania Pulverizing Co.

Stilts
Potters Supply Co., The

Stoneware (Chemical)
Nashville Industrial Corporation

Sulphuric Acid
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.

Temperature Instruments (Measuring)
Charles Engelhard, Inc.
Wilson-Maeulen Co., Inc.

Thermometers (Electric Resistance)
Charles Engelhard
Wilson-Maeulen Co., Inc.

Tile Machinery (Floor and Wall)
Mueller Machine Co., Inc.

Tubes (Insulating)
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

Tubes (Pyrometer)
Brown Instrument Co.
Charles Engelhard, Inc.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

Tunnel Kilns
Russell Engineering Co.

Vacuum Pumps
Mueller Machine Co., Inc.

Whiting
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.

Zirconia
Vitro Mfg. Co.

ALPHABETICAL LIST TO ADVERTISERS

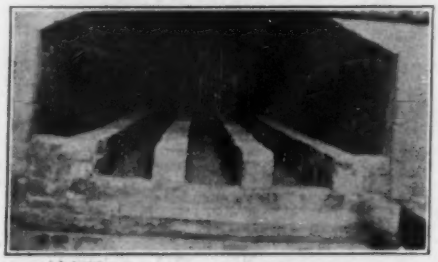
	Page
Brown Instrument Co.	21
Chambers Brothers Co.	16
Chicago Vitreous Enamel Product Co., The	1
Drakenfeld and Co., B. F.	11
Dominion Feldspar Corporation	13
Edgar Brothers Co.	16
Engelhard, Charles Inc.	14
Feldspars Limited	17
General Electric Co.	8
Golding-Keene Co.	12
Hadfield-Penfield Steel Co.	13
Hardinge Co.	6
Harshaw, Fuller and Goodwin Co.	2
Journal of the Society of Glass Technology	16
McDanel Refractory Porcelain Co.	12
Manufacturers Equipment Co.	15
Montgomery Porcelain Products Co.	13
Mueller Machine Co., Inc.	22
Nashville Industrial Corporation	14
O'Brien and Fowler	12
Old Hickory Clay & Talc Co.	14
Paper Makers Importing Co., (Inc.)	21
Parker-Russell Mining & Mfg. Co.	10
Pennsylvania Pulverizing Co.	20
Pennsylvania Salt Mfg. Co.	22
Philadelphia Drying Machinery Co.	17
Porcelain Enamel & Mfg. Co.,	Inside Back cover
Potters Supply Co., The	16
Proctor and Schwartz, Inc.	4
Roessler and Hasslacher Chemical Co.	Inside front cover
Russell Engineering Co.	20
Seaboard Fuel Corporation	19
Surface Combustion Co.	12
United Clay Mines Corp.	Back Cover
United Alloy Steel Corp.	—
U. S. Smelting Furnace Co.	3
Vitro Manufacturing Co.	15
Wilson-Maeulen Co., Inc.	10

(When writing to advertisers, please mention the JOURNAL)

VITREOUS ENAMELING FURNACES

Utilizing Clark patented principle of intermittent and direct firing
(The Surface Combustion Co.—Sole Licensee)

16 MONTHS WITHOUT REPAIRS
AND GOOD FOR SEVERAL YEARS MORE



Unretouched photograph of interior of Surface Combustion Enameling Furnace in operation 6 days per week for 16 months with no repairs whatever.

Write now for full details and engineering data.

Branch Offices:
Chicago
Philadelphia
Pittsburgh
Baltimore

THE SURFACE COMBUSTION CO.
Engineers & Manufacturers of
Industrial Furnaces for all purposes

Main Offices and Works:
Gerard Ave. & 145th St.
Bronx, N. Y. C.

5-22

COAL, COKE, GAS, OIL FIRED

ENAMELING MUFFLES
SMELTERS
INDUSTRIAL FURNACES

DESIGNERS AND BUILDERS
HIGH GRADE FIRE BRICK, SPECIAL TILE
SILICA BRICK AND TILE, ETC.

YOUR INQUIRIES WILL RECEIVE PROMPT ATTENTION

THE PARKER RUSSELL
MINING AND MANUFACTURING CO.

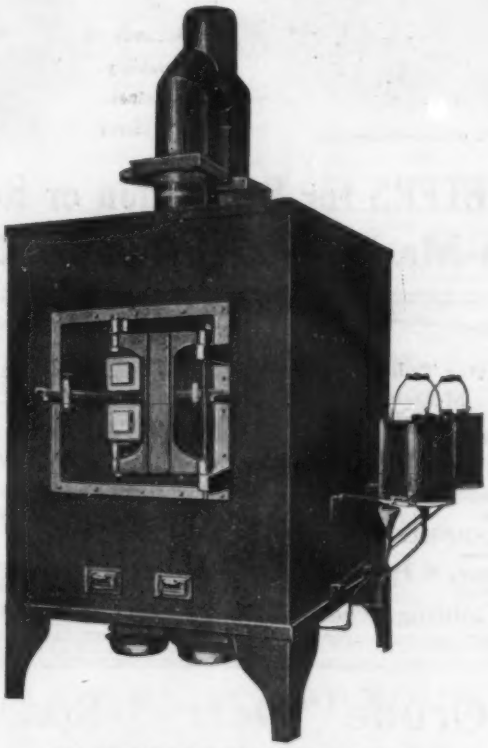
ST. LOUIS, MO. 603 LACLEDE GAS BUILDING

PERFECTION POTTERY KILNS

FOR FIRING BISCUIT, CLAY BODIES AND GLAZES

EQUIPPED FOR KEROSENE OIL

MANUFACTURED GAS OR NATURAL GAS

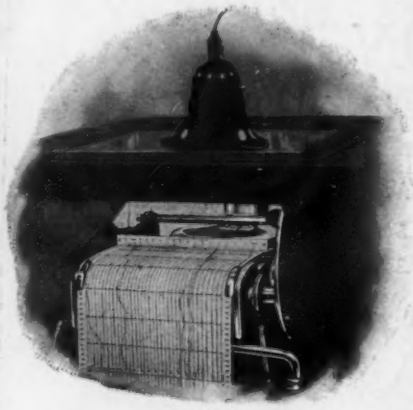


NO. 12 PERFECTION POTTERY KILN
Equipped with Kerosene Oil Burners

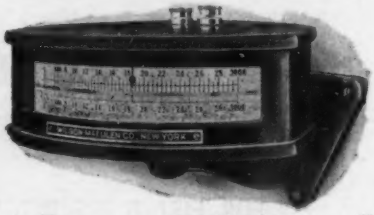
B. F. DRAKENFELD & CO., Inc.

50 MURRAY STREET NEW YORK, N. Y.

ILLUSTRATED CATALOG MAILED ON REQUEST



TAPALOG (Multi-Recorder)



The
TRUEST
Combination
of
Accuracy
Durability
Robustness
Convenience

PYROMETERS for Production or Research

Wilson-Maeulen Co., Inc. 386 Concord Ave., New York

5-22

TRADE MARK

Pyrometer Tubes—Protection Tubes—Combustion Tubes
McDanel Refractory Porcelain Company
Beaver Falls, Pennsylvania

UNUSUAL · SHAPES · OUR · SPECIALTY ·

The
GOLDING-KEENE CO.
Plant at Keene, N. H.

FELDSPAR

The Finest Spar
for
The Finest Ware.

Charles E. Golding, President — J. Alfred Dennis, Manager.

Crude "Derry" Spar

Sold direct to millers or to potters who grind

O'BRIEN & FOWLER
114 Wellington Street,
Ottawa.

Quarry: Buckingham, Que.

If you want pyrometer protection tube satisfaction
USE
Montgomery Hard Porcelain Pyrometer Tubes
All Sizes and Lengths for either Platinum or Base Metal Couples
The Best Liked and Most Largely Used Protection Tubes on the Market today
If the manufacturer of your pyrometer equipment cannot supply you, write us direct.
TRADE MARK
MONTGOMERY PORCELAIN PRODUCTS CO.
FRANKLIN, OHIO, U. S. A. 10-22

FELDSPAR
PAR EXCELLENCE
from
CANADA

UNIFORMITY—QUALITY—SUPPLY

All assured for years to come to users of the famous "DERRY" spar from the celebrated O'Brien & Fowler mine at Buckingham, Quebec, Canada.

EVERY CARLOAD GUARANTEED
Samples and analysis gladly submitted on request
Address all correspondence to
DOMINION FELDSPAR CORPORATION
ROCHESTER NEW YORK

THE HADFIELD PENFIELD STEEL CO.
BUILT RIGHT RUN RIGHT
BUCYRUS OHIO

CLAY PLANT EQUIPMENT

We build every machine and appliance required for making various Clay Products. Correspondence solicited. We also build Rotary Driers, Cement Mchy., Fuel Oil Engines (Diesel Type), Gasoline Locomotives, Ship Deck Equipment, etc.

The Hadfield-Penfield Steel Co., Bucyrus, Ohio.
Formerly The American Clay Mchy. Co.
1-22

A WORD FROM THE MEMBERSHIP COMMITTEE.

EVERY MAN in the Ceramic field owes it to himself and to the industry to be a member of THE AMERICAN CERAMIC SOCIETY.

The growth of the Society shows its increasing importance. Membership means influence and prestige for every man affiliated.

The circulation of the "Journal" is keeping pace with the growth of the Society and the advertising is increasing as well. Every membership received means greater possibilities in its work.

For full information address—

O. O. BOWMAN, 2nd, Chairman Membership Committee — BOWMAN COAL CO. Trenton, N. J.

CHEMICAL WARE & MACHINERY

From the Old Hickory Powder Plant. An immense amount of new and slightly used chemical stoneware, Duriron, laboratory equipment, technical machinery, boilers, engines, etc., now available for immediate delivery at extremely low prices. Write for Bulletin No. 14.

NASHVILLE INDUSTRIAL CORPORATION, Jacksonville, Tenn.

1917 **Quality — Service — Reliability** 1922

The highest grade, superior quality, Ball and Sagger Clays for all purposes—Prices in line—Perfect Service—We mine and prepare our own clays. Try them and cut your plant costs.

Old Hickory Clay & Talc Co., Inc.

PADUCAH The company with the Clay and the Service Kentucky

A WORKING TOOL

More and more are the operating men in industry coming to realize the need of equipment for accurately and continuously indicating and recording temperature.

ENGELHARD PYROMETERS

are helping many in the ceramic industries. You will find that they give long accurate service with a surprisingly low maintenance cost.

That's why so many people say that

Engelhard Pyrometers Are Good Pyrometers to Standardize on

Charles Engelhard, Inc.

30 Church Street, Cat.—S-2. New York City

ZIRCONIA

Natural Dioxide

powdered——granulated

White Refined Dioxide

free from iron

ENAMELS IN ALL COLORS

For **CAST** Iron

Coloring Oxides

For **STEEL**

Vitro White

We Have Faith in Our Goods so We Advertise Here——

The Underwood Producer Gas System, patented, saves fuel and labor in burning clayware, baking carbon products, roasting ores, heating lehrs in glass factories, also revolving pots, etc., and enameling metal ware.

The Justice Radiated Heat and Waste Heat Dryers for drying structural clayware have no equal in economy and efficiency.

"Meco" Single Roll Rock and Shale Crushers, Elevators, conveyors, and feeders make up the most complete clay preparing outfit, a necessity in every clay plant when material must be ground and screened. Write us about these things. To answer is our pleasure.

THE MANUFACTURERS EQUIPMENT CO.

Dayton, Ohio, U. S. A.

9-22

Quality *Uniformity* *Experience*

Edgar QUALITY Clays

REALLY washed—Highest percentage clay substance

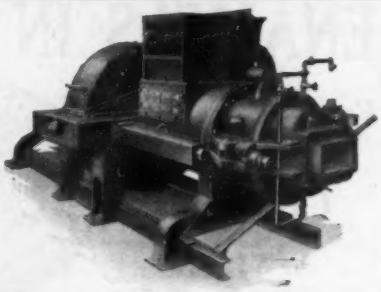
Brands	Produced by
Edgar Florida Kaolin	Edgar Plastic Kaolin Co.
Edgar Georgia Paper Clay and Kaolin	Edgar Brothers Co.
Lake County Florida Clay	Lake County Clay Co.

One Management—Office, Metuchen, N. J.

12-21

Brick Making Machines

Crushers Grinders Mixers
Automatic Cutters



Chambers Bros. Co.
Philadelphia Pa.

The Journal of the Society of Glass Technology

A quarterly Journal containing original papers and abstracts of papers covering the whole field of Glass Technology.

Annual Subscriptions to Society (including Journal)

Ordinary Members	$ 7.00
Collective Members	$15.00
Price per Number to non-Members	$2.50
Price per volume (unbound) to non-Members	$9.00

Forms of application for Membership may be obtained from the American Treasurer of the Society, Mr. Wm. M. Clark, Ph.B., Nela Park, Cleveland, Ohio.

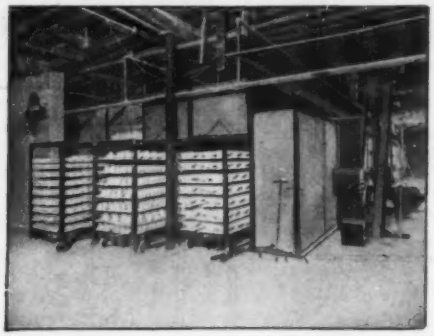
Address orders and inquiries to: The Secretary Society of Glass Technology, The University, Sheffield, England

WE manufacture Pins, Stilts, Saggers, Tile for Decorating Kilns.

WE handle the best grades of American Ball Clay, Sagger Clay, Wad Clay, Bitstone, Imported Paris White and Domestic Whiting.

For full information Address

The Potters Supply Co.
East Liverpool Ohio.



"HURRICANE" DRYERS FOR ELECTRIC INSULATORS

Prominent Electric Insulator and Porcelain mannfacturers are cutting many days from their drying schedule with equipment such as this.

These machines take up a minimum of floor space, produce better ware and reduce operating costs.

Our representatives and engineers are always ready to help you.

SEND FOR CATALOGS

The Philadelphia Drying Machinery Co.
Philadelphia, Pa.

FELDSPARS LIMITED

R. F. SEGSWORTH—PRESIDENT

Operating Richardson Mine. Continuous shipper of a High and Uniform grade of Pink Feldspar and Flint for seventeen years.

Write for quotations on carload shipments.

Head Office—103 Bay St.

TORONTO CANADA

The January issue of The Ceramic JOURNAL will be a

Special Anniversary Number

devoted to the activities of The Ceramic Society for the past 25 years.—It will be an issue you will want to keep and refer to.

Your company's announcement should certainly be in our columns.

For full particulars address—

American Ceramic Society

170 Roseville Ave. Advertising Department Newark, N. J.

CLASSIFIED ADVERTISING

Professional Services

TECHNICAL GRADUATE desires position in Southern California. Thirteen years' clay manufacturing experience. Address "Box 18"—American Ceramic Society, 211 Church St., Easton, Pa.

Do you require help?
Make your wants known
by advertising here.

WANTED — used Pottery Printing Press. What have you to offer. Address "Box 19"—American Ceramic Society, 211 Church St., Easton, Pa.

Being an engineer will not guarantee employment of your services — You must tell what you have done and can do—Let those who need your services know about you and your ability.

(When writing to advertisers, please mention the JOURNAL)

Are You Using the Right Kind of Coal for Kiln Firing?—

For many years it has been our pleasure in supplying the most discriminating Potteries in the East with—

High Grade Bituminous Coal

LOW ASH
SULPHUR
VOLATILE

Our Engineering Department will gladly go into details

SEABOARD FUEL CORPORATION
1610 Spruce St.
PHILADELPHIA, PENNA.

Russell
Tunnel Kiln

This company has no Tunnel Kiln Plans to sell. Therefore our responsibility does not end with the design. We furnish all the material and *we* construct the complete kiln. Then we stay on the job until economical and satisfactory production is assured.

Write for new booklet, "Modern Firing"

RUSSELL ENGINEERING COMPANY
Railway Exchange Bldg., St. Louis, Mo.

E-543

PENNSYLVANIA PULVERIZING CO.

LEWISTOWN, PENNA.

Pure Canadian Potash Feldspar

Potters Flint **Placing Sand**

SALES OFFICE
341 Fourth Avenue
Pittsburgh, Pa.

Performance has two dimensions--

Quality and Quantity

We could tell you of the endless research in both field and laboratory that has developed such improvements as Automatic Temperature Control. We could point with pride to equipment that winds moving elements with wire as fine as a hair—or to the 101 other differences in Brown methods that are responsible for Brown accuracy and stamina.

But it's what Brown instruments do in the field, in everyday, hard service that counts.

In the field Browns are supreme. There are nearly as many Brown Pyrometers in use in America as all other makes combined—because they make good, and keep right on making good, without coaxing.

THE BROWN INSTRUMENT CO.
Wayne Junction Philadelphia, Pa.

New York Pittsburgh Detroit Cleveland Chicago
St. Louis Denver San Francisco Los Angeles Montreal

BROWN PYROMETERS

1892 ——— MEANS ——— 1922

THIRTY YEARS IN THE GRAND OLD SCHOOL OF EXPERIENCE

ENGLISH AND DOMESTIC

CLAYS
FOR
ALL
CERAMIC
PURPOSES

PMIC-Inc. MEANS—SERVICE, QUALITY AND PRICE

PAPER MAKERS IMPORTING CO., INC., EASTON, PA.

9-22

SOLE IMPORTERS OF

KRYOLITH GENUINE **GREENLAND**
FOR THE GLASS AND ENAMEL TRADES

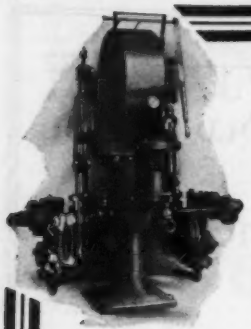
MANUFACTURERS OF

NATRONA HYDRATE and OXIDE
FOR THE GLASS, ENAMEL AND PORCELAIN TRADES

ALUMINA

And Other INDUSTRIAL CHEMICALS

Pennsylvania Salt Manufacturing Co.
PHILADELPHIA, PA.
New York Pittsburgh St. Louis Chicago



THE MUELLER PUMP

Is assisting the most progressive potters in improving their ware.

Do you know the advantages of this pump and how it is increasing production?

Why not give us the opportunity to explain.

Our catalog is yours for the asking

THE MUELLER MACHINE CO., Inc.
TRENTON, NEW JERSEY
P. O. BOX 758

RELIABLE PORCELAIN ENAMELING PLANTS

Present day demands in the porcelain enameling industry require utmost reliability and service. The best is not only the cheapest in the long run, but it insures a positive guarantee of quality that makes for repeat orders and increasing business.

This company has developed under its well known PEMCO trade name, three fundamental features of operation in connection with porcelain enameling plants, covering

COMPLETE EQUIPMENT
COMPLETE LINE OF PORCELAIN ENAMELS
COMPLETE SERVICE

To each of these, we have devoted the utmost care and attention to the last detail. You can enjoy the benefit of this broad experience, with an assurance of permanent satisfaction and greatest results.

We are in position to design and equip your plant.
We are in position to furnish you with the best porcelain Enamels and such as you may require for your particular work.
We are in position to give you the best service to insure continuous and reliable production.

Put your requirements up to us.

The Porcelain Enamel & Manufacturing Co.
BALTIMORE, MD.

When writing to advertisers please mention the JOURNAL

ENGLISH BALL CLAY

OF THE

Highest Quality

IS ONE OF OUR SPECIALTIES

PROMPT DELIVERIES

AT RIGHT PRICES

UNITED CLAY MINES CORPORATION

MINERS OF HIGH GRADE CLAYS OF ALL KINDS

GENERAL OFFICES TRENTON, N. J.